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THE TORPEDO BOAT "CUSHING," launched at Bristol, R. I., on Jan. 23, from the Herreshoff yard, is the first of our sea-going torpedo boats completed. The *Cushing* is 138 ft. long, 15 ft. beam and has an extreme depth of hold of 10 ft. with a draught of 4 ft. 4 in. The engines are quadruple expansion, with five cylinders of 11¼, 16 and three of 22 in. diameter. There are two propellers. The displacement is a little over 100 tons and the calculated horse power is 1,600, or about 16 H. P. per ton of displacement. Two bow-torpedo tubes will form the armament of this craft. The guaranteed speed demanded is 23 knots with a bonus of $1,500 for every quarter-knot in excess, and $2,000 for every quarter-knot in excess of 24 knots.

A SIMPSON DRY DOCK is to be built at Savannah within the year, says a "special" from that city. The dock will be a private enterprise, and cost $500,000.

THE CITY OF BOMBAY is extending its water supply, and has bought two Worthington triple-expansion engines and two Babcock boilers for this purpose. As Mr. TOMLINSON, the Executive Engineer of the Water Works, was lately in this country, examining American plants and methods, this purchase is probably one of the results of his visit.

THE MILWAUKEE FLUSHING TUNNEL is in operation. It cost $250,000. A tunnel 2,500 ft. long and 12 ft. in diameter connects the river and lake; and through this 45,000 cu. ft. of water per minute is pumped from the lake, says the Milwaukee *Sentinel*. The pump used is placed within the conduit and is in form something like a propeller wheel, 13 ft. in diameter and with a solid center 6 ft. in diameter. This pump has a reported duty of 68,800,000 ft. lbs. per 100 lbs. of coal consumed, a remarkable duty for a pump of this type.

THE WASHINGTON WATER-WORKS TUNNEL is again before Congress in the form of a resolution presented in the House on Jan. 25. Quoting the experts' report as proving that the tunnel is absolutely worthless, and that the $2,575,279.30 expended on this work is without return to the city in the form of an increased water supply, the resolution requests the Secretary of War to inform the House whether the contractors and subcontractors for the work of lining the tunnel can be held individually liable for the loss incurred. Also, whether they can be criminally prosecuted. If this resolution is pushed it will open up some nice questions concerning the relative responsibilities of engineers and contractors.

ROCK ISLAND ARSENAL is to be transformed into a manufactory of great guns, if the Government will consent. Col. J. M. WHITTEMORE, late in command at Watervliet Arsenal, is now in charge at Rock Island, and is overlooking the latter site for its advantages as a gun foundry. There are there now 10 acres of shop floor, and a water privilege of 1,900 H. P. available, and this power can be transmitted by means of wire rope and shafting. A stone dam is now being built there, with Mr. CHAS. FRANCIS as engineer in charge.

ANOTHER SERIOUS CAR-STOVE ACCIDENT, by far the most serious railway accident of the week, has followed the Cincinnati, Hamilton & Dayton accident of last week. This accident was on the "Monon" line (Louisville, New Albany & Chicago Ry.), near Carmel, Ind., about 17 miles north of Indianapolis; six persons were killed and some 30 injured, half of them seriously. But one of the killed was burned to death. There was an "unexplained derailment" just before reaching a trestle, which had the murderously poor style of floor, which we regret to say, is the prevailing type. It was a comparatively slow express and theatre train, consisting of an engine, combination baggage car, two coaches, and a Pullman. The train was running 25 miles an hour, and the engine and first two cars passed over in safety, as so often happens, bunching the ties and otherwise tearing up the floor so that the two rear cars fell through it sidewise and "immediately caught fire from the stoves. In a few minutes they were a mass of flames. The shrieks of the injured were terrible. There were about 25 persons in the ladies' car, and of that number five were killed and all but two or three of the others injured more or less." Among the killed were two poor little children, on whom the hot stove fell, pinning them bodily to the wreck, while they were burned up before their mother's eyes; although there is reason to hope that they were killed by a blow from a seat before they were burned.

Still another car stove accident was on the Denver & Rio Grande R. R., near Monument Station. According to the press report, "the Atlantic express arrived at Monument 15 minutes late, and just as it pulled up at the depot two coaches and a sleeper were blown off the track by a terrific hurricane; the wrecked coaches rolled down the embankment, *taking fire immediately*. The scene was heartrending. A mass of burning coaches and human forms burned and bruised and scalded, shrieking and groaning, imprisoned with no available avenue of escape, and the raging of the storm added terror to the scene. Twenty or more passengers were confined in the coaches, and but for the almost superhuman efforts of the trainmen they would have been roasted alive. All were terribly shaken up and bruised. A porter was fatally scalded, and two others badly injured. The prompt action of the trainmen in extinguishing the fire doubtless saved scores of lives and much valuable property."

TWO RAILWAY ACCIDENTS recently have shown the need of derailing switches at the approaches to drawbridges. An express train on the New York & New Haven Railroad was derailed at the drawbridge over the Housatonic River on Jan. 24. The drawbridge had just been closed, but the danger signal had not been lowered nor the switch set for the main track. There is a derailing switch at this point, so arranged that when the danger signal goes up it opens the switch. The railway officials say that the engine driver failed to notice the signal, and that when he discovered the mistake it was too late to stop.—On Jan. 21, a train on the Long Island Railroad narrowly escaped a serious accident at the drawbridge over Dutch Kills creek. The creek is about 40 ft. wide at this point. This draw was wide open, and the train approached it at full speed, the men in the cab being entirely unconscious of the impending danger. The draw tender fortunately saw the engine approaching, and realizing that the engine driver was not aware of the danger, jumped to his post and began closing the bridge. He succeeded in closing it only just in time. The engine driver and fireman were considered responsible and were discharged.

HEAVY FLOODS in California are succeeding the recent snow storms, and several washouts have been caused and bridges damaged or carried away. The approaches of two railway bridges over the San Lorenzo River, near San Jose, Cal., were carried away Jan. 25. The West Point bridge across the Mokelumne River, 20 miles above Jackson, Cal., gave way Jan. 16.

TWO DAMS are reported to have been carried away, a milldam near Gloversville, N. Y., and the dam of an irrigation reservoir and ditch near Woodland, Cal.

A SINGLE OVERHEAD BRIDGE at Albion, N. Y., killed last week its *fourteenth* victim, all brakemen standing on top of trains and not sufficiently on the lookout.

THE COLORADO CAÑON SURVEYING PARTY is reported in a press dispatch to have lost "one-fourth of its number" by drowning in Marble Cañon. As the entire party only consists of six or seven members, we hardly believe this report is correct. Were there any real foundation of fact for it, the actual number drowned would have been almost certain to be stated. Still, it is undoubtedly a dangerous service, and the report may be true.

THE CORONER'S JURY IN THE LOUISVILLE CAISSON ACCIDENT, "finds and believes, from the evidence, said accident was the result of a part of the men in said caisson losing their presence of mind and becoming panic-stricken from some unknown cause, forcing open the lock-gate at the time leading from said caisson, thereby allowing the pressure to escape, and as a result the caisson filled with water and sand. And we further find that said accident was not due to any carelessness on the part of Sooysmith & Co." This finding, unlike that of the average coroner's jury, is probable; and as nearly explains the true cause of the accident as will ever be possible.

THE HENDERSON BRIDGE CASE, in its second trial, was concluded on Jan. 24 with a verdict of $148,633.61 against the Henderson Bridge Co. in favor of the contractors, O'Connor & McCulloch. The history of the Henderson Bridge case is that in 1881 O'Connor & McCulloch took the contract for building the bridge across the Ohio River at Henderson, Ky. It was to be a drawbridge. Meantime, before any work could be done and after the contracts were let, the plaintiffs claimed that the original plans were changed so that they had to delay 18 months before they could begin work. It was finally proposed to build a through bridge so high that a draw would not be required, and the time was consumed in getting a bill through Congress. Meantime, the change in the plan had necessitated a change in the size, location and general character of the piers, and O'Connor & McCulloch claimed that they had to keep their laborers idle at almost a dead expense. The plaintiffs took hold and worked until April, 1884, when, for reasons about which there are conflicting statements, the defendant company proposed to annual its contract. The plaintiffs denied the right of the company to do this, and got out an injunction in Chancery and proposed to stand their ground. The defendant, however, held that the injunction was not broad enough to cover all the claims of the contractors, and on that ground sent down about two or three hundred section hands, in charge of competent men, to continue the work. O'Connor, the contractor, stood the ground with his men, and refused to budge. The result was almost a little war, and after a siege of three days O'Connor had to give up and take his men away from the work. The company then took charge of and completed it. The Chancellor decided that the annulment of the contract was illegal, but that the recourse of the plaintiffs was by an action for damages, and hence the suit was filed.

THE CAR-STOVE SUIT of the people against the New York, New Haven & Hartford R. R. Co., to recover $7,000 penalties for failure to comply with the act requiring steam heat to be supplied instead of stoves in the cars of all railroads in the State over 60 miles in length, has been decided against the road in the special term of the Supreme Court on a demurrer interposed on the ground that only 26 miles of its road are in the State of New York. The judge

held, and very properly, that the act applied to all trunk lines coming within the State.

THE NEEDLES BRIDGE, on the Atlantic & Pacific R. R., is now progressing rapidly. The single pneumatic caisson, which Sooysmith & Co. are sinking, is now about 60 ft. below the surface, and is nearing completion. Material for the 660-ft. cantilever bridge is being delivered.

THE PHILADELPHIA AND CAMDEN BRIDGE BILL, recently introduced into Congress, is the resuscitation of a long-time dormant project. The proposed bridge, of which THOMAS S. SPEAKMAN is the designer, is to be a suspension structure connecting the cities of Philadelphia, Pa., and Camden, N. J. It will be 4,440 ft. long, 135 ft. high, and will accommodate railway, carriage, and pedestrian traffic. The backers are said to be an English syndicate of iron manufacturers which stands ready to build the structure as soon as the necessary authority is obtained.

THE HAWK ST. VIADUCT, in Albany, N. Y., was practically opened to travel on Jan. 22. This bridge has already been described in our issue of Feb. 16, 1889. The bridge is a steel arch designed by Mr. ELNATHAN SWEET, C. E., President of the Hilton, Bridge Co , and it was built by his company for a bid of $107,000. Ground was broken on April 15, 1989. Mr. P. C. RICKETTS, of Troy, N. Y., was the Engineer in charge.

THE HENNING TUNNEL, under the East River, was incorporated this week with $100,000 capital. It would start from South Seventh St., Brooklyn, and land at Broome St., New York, three-fifths of a mile in total length. The directors are: BENJ. S. HENNING, T. A. PATTERSON, ROBT. WHITEHALL, H. C. HILMERS, GRENNELL BURT, C. H. ODELL, Otto ANDBEÆ, ALEX. CURTIS and J. C. O'BRIEN, of this State, and C. W. SMITH, of Chicago.

THE FORTY-SECOND STREET TUNNEL SCHEME is being vigorously revived. This is the plan to connect by a tunnel the Long Island Ry. and the Vanderbilt system of lines by a tunnel under the East River. The President of the New York & Long Island Tunnel Co. is Mr. JAMES D. LEARY; Vice-President, Gen. ROY STONE, and MALCOLM W. NIVERS is Secretary. The board of directors includes the names of Mr. P. P. DICKINSON, of the Poughkeepsie bridge, and Mr. JOHN BOGART, State Engineer. The tunnel will be about five miles long, and come to the surface on the New York side at Forty-second St. and Eleventh Ave. The maximum cost is estimated at $1,000,000 per mile. It is to be 26 ft. wide and 22 ft. high, and the greatest depth under the East River will be from 50 to 60 ft. The tunnel would be 135 ft. below the surface at First Ave., 150 ft. at Second Ave., 123 ft. at Third Ave., 124 ft. at Lexington Ave., 135 ft. at Madison Ave., 126 ft. at Fifth, 129 ft. at Sixth, 98 ft. at Seventh, and 50 ft. at Ninth Ave.

THE MONTREAL SUBWAY CO. is asking for incorporation with a capital of $100,000. The company is composed of WM. VAN HOOTEN, C. E.; E. H. POTTER, of New York; WM. B. TURNER, M. E., of Boston; JOSEPH O. DUPUIS and JAMES COCHRANE, of Montreal. The purpose of the company is to lay underground telegraph, telephone and electric light wires. The company is not very modest in its demands. It wants exclusive privileges for 40 years; all other companies must pay such rates as the subway company may name; it can open any street, etc., in Montreal eight days after notice is given to the authorities, and no company or corporation shall in any way be allowed to interfere with the subway company.

THE SENATE NAVAL COMMITTEE favorably reports the bill of Mr. HALE providing for the construction of eight battle ships of from 7,000 to 10,000 tons displacement, two armored coast defence vessels, three gunboats and five first-class torpedo boals. The total cost of these vessels would be about $50,000,000.

THE ST. LOUIS CAR SERVICE ASSOCIATION has reduced the average detention of cars in that city rom 6 to 10 days in November, 1888, to 2 days in November, 1889, and 1.9 days in December, 1889.

Clearing Water by Settlement; Observations and Theories.

(*Concluded from page 609.*)

The general conclusions deduced from these experiments were as follows: (1) The basins should not be covered. (2) In the time that could be allowed for settlement, there would be no material difference in clearness from the top downward. (3) That the time occupied in filling the basin could not be counted in the period required for ultimate clearing; for though a considerable quantity of the heavier sediment was deposited during the operation of filling, this filling must stop before the internal currents set up could commence to die away. These internal currents were the controlling element in the final clearing of the water. (4) The size and shape of the basin would have little effect in retarding the internal currents. This retardation really depended upon the rate at which the initial motion was consumed by friction between the several interlacing internal currents; the effect of the confining surfaces upon these currents is simply a factor in the general result.

The above conclusions were further confirmed by the study of observations made under the direction of Col. HENRY FLAD on settlement in a 36-inch pipe 12 ft. long, set vertically. These are called the Stand-Pipe Data; and though made from laboratory experiments, and some doubt existing as to whether settlement followed the same laws in receptacles differing so widely in size, study of the data lead to the conclusion that at most the difference is very slight.

In these data the clearness of the samples was determined by the comparator readings, and the determination of sediment by weight in parts per 1,000 was made without a moisture correction. Continuous observations were made at several depths with a view of determining whether the retardation was the same in the stand-pipe as in the basins. It was found that the methods of measuring density had not been sufficiently precise to reach altogether satisfactory results; but it was enough to justify the statement that there was not much difference.

Of the rest of this data two groups have been made showing the marked differences in the rate of clearing of the water at different times, and contrasting the mean rate of clearing in the stand-pipe with the clearing effected by the basins on about the same water. This is presented in the following tabulation, and the clearing is shown, plotted to time of standing, in Fig. 5.

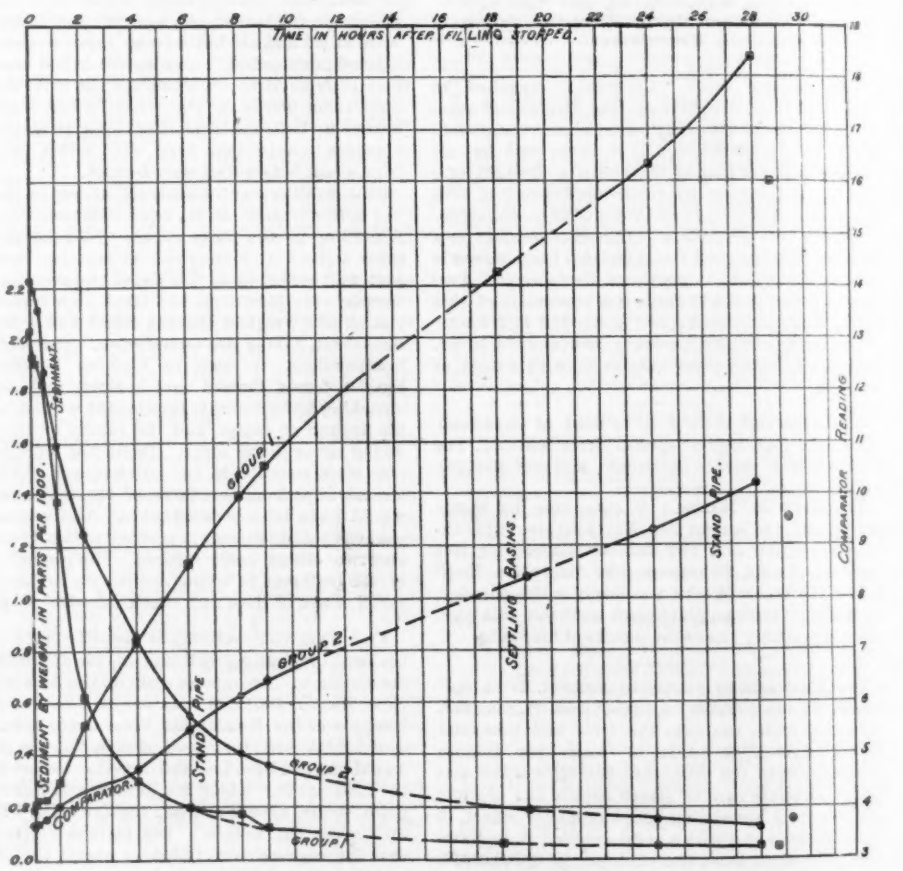
STAND-PIPE DATA.

Mean Progress of Clearing in Stand-Pipe and Settling Basins.

Samples taken from—	Group I, April 13, 20, 27, and June 22, 1886. Time after filling in hours	Comparator readings.	Sediment by weight in parts per 1,000.	Group II, May 18 and June 29, 1886. Time after filling in hours.	Comparator readings.	Sediment by weight in parts per 1,000.
Stand-pipe	0.0	3.95	2.634	0.0	3.67	2.224
" "	0.1	4.08	1.932	0.1	3.62	2.190
" "	0.2	4.13	1.909	0.2	3.68	2.115
" "	0.5	4.15	1.830	0.5	3.78	1.856
" "	1.0	4.49	1.375	1.0	4.03	1.589
" "	2.0	5.57	0.627	2.0	4.33	1.250
" "	4.0	7.17	0.303	4.0	4.74	0.858
" "	6.0	8.67	0.202	6.0	5.50	0.559
" "	8.0	9.99	0.179	8.0	6.17	0.414
" "	9.0	10.58	0.127	9.0	6.44	0.373
Settling basins	18.1	14.29	0.062	19.1	8.43	0.187
Stand-pipe	24.0	16.33	0.050	24.0	9.33	0.155
" "	28.0	18.41	0.055	28.0	10.22	0.123
Settling basins (thr'gh dr'wing)	28.7	16.01	0.045	29.3	9.55	0.152

The samples of water in the stand-pipe were taken at a depth of 6 ft. and at the uniform times given. The basin samples were taken at the surface just before drawing, and the time is the mean time of the basins standing. The second basin sample was taken from the surface just before drawing was stopped, and is indicated as "through drawing."

The observations on clearing in the stand-pipe most unfortunately lack data for the period from nine to twenty-four hours after filling; but the period from eighteen to nineteen hours correct by the samples from the basins, are sufficiently in line with the general direction of the clearing observed in the stand-pipe, before and after, to show that, though the basins were so different in volume and subject to



Stand-Pipe and Basin Diagram.

the effects of winds, yet some time after filling stopped, the water must have followed very closely the same clearing in the basins that took place in the stand-pipe.

The increased clearing, though with a decreased rate, of the samples taken from the basins at the end of drawing, served to confirm a conclusion that had been reached by S. B. RUSSELL, Principal Assistant Engineer, through a direct comparison of samples taken under his direction. This partial settlement during drawing was taken at one half the rate of quiet deposit, as sufficiently close for practical purposes.

We may therefore sum up the results of the observations and experiments as follows: That filling one basin at a time, and allowing it to stand until needed for drawing, is the most economic system. That these basins should not be covered. That their design, depth and dimensions could be simply based on the economic storage of volume. That their number should be based on making the time of standing a maximum, allowing one quarter the time of drawing as also time of standing (that is, half settlement on an average half-basin volume). The economic period of settlement is not a matter that is capable of so definite an answer.

It was noticed during the experiments that the retardation increased rapidly as we approached the sediment of 2 ft. per hour subsidence, or of 32 to 34 hours retardation; but in the case of water having a large amount of this finer sediment, while complete settlement of any class would progress very slowly, the straining out of the finer grades might be a desirable gain to clearness. This problem can then only be a special study of the average worst water to be settled.

In a system designed for the increasing demand of a growing city, however, a very close determination of the economic period is not necessary, for in fixing the dimensions of the system it has to be combined with the prospective rate of increased service; the possibility of special treatment in the future, either by filtration or coagulation during the periods, of especially bad water; as well as by the amount of money that may be available at the present for this part of the water works.

But since the whole problem must probably always be in part a local one, dependent on the characteristics in regard to clearing of the special water to be treated, it is believed that the general conclusions may be accepted as valuable. And observations on the clearing of any water may be made on a scale approximately that of the 36-in. pipe, and in the stand pipe data; and that we may count upon getting about the same clearing of water, in large open reservoirs, with the times of standing respectively equal to the experimental observations. In this way the relative efficiency of systems of continuous flow in actual operation may be easily tested; and such observations as should precede the planning of new systems may be made with little difficulty.

Performances of the Best Modern Pumping Engines, Compared to that of the Cornish Pumping Engines in the Period of 1840.

By Prof. J. E. DENTON, Stevens Institute of Technology.

[*Continued from page 76.*]

TEST OF PAWTUCKET ENGINE—PRINCIPAL RESULTS.

I. Anthracite Test.

Date of test, May 30-June 1, 1889.
Duration of test, 72 hours.

ENGINE.

Cut-off.		Bore.	Stroke.	Clearance.	Port areas in per cent. of piston area.	
					Admission.	Exhaust.
High cyl.	0.22	15 ins.	30 ins.	4 p. ct.	9.4	14.8
Low "	0.335	30⅛ "	"	3.7 "	5.4	9.8
Pump "		10.53"	....	....	...	....

Jackets envelop both cylinders, including heads.
Volume of receiver approximately equal to volume of low cylinder.

Revolutions per minute	49.03

BOILERS.

Number in use	3
Water-heating surfaces	1,231 sq. ft.
Superheating surface	508 sq. ft.
Grate surface	45 sq. ft.
Ratio heating to grate	38.6 to 15

PRESSURES.

Average boiler pressure	127	lbs.
" receiver pressure	8½	"
" vacuum	28.5	ins.
" back pressure low cylinder	1.25	lbs.
" water pressure against pumps	115.0	"
" suction pressure against pumps	5.78	"
" barometric pressure	30.0	"

TEMPERATURES.

	Deg. Fahr.
Average temperature of saturated steam at average boiler pressure	353
Average temperature of steam in steam pipe two feet from steam chest	356
Average degrees of superheating two feet from steam chest	3
Average temperature of feed water entering boilers	104
Average temperature of feed water leaving hot well	92.1
Average increase of temperature of feed water due to admixture of jacket water	11.9
Average temperature of jacket water entering feed pipe	310
Average temperature of condensing water leaving suction well	63
Average temperature of gases at exit from boiler flues	428
Average temperature of gases after passing heater in flue, through which condensation from receiver was circulated	354
Average temperature of water blown to waste from receiver	225
Average temperature atmosphere	70

TOTAL QUANTITIES.

Anthracite coal	15,710 lbs.
Equivalent of wood, 4-10 × 263-lbs	105 lbs.
Total	15,815 lbs.
Ashes, clinker, etc	2,238 lbs.
Steam fed to boilers, including condensation from jackets	140,969 lbs.
Condensing water	4,201,337 lbs.

HOURLY QUANTITIES.

Fuel	219.5 lbs
Feed water	1,955 lbs
Condensing water	58,351 lbs.
Condensed in jacket	107 lbs.
" through receiver	156 lbs.
Blown to waste from receiver	118 lbs.
Re-evaporated by fine heater	38 lbs.
Average indicated horse power steam cylinders	143.49
Average indicated horse power pump cylinders	138.36
Average horse power to overcome friction of engine, including air pump	5.13
Average horse power to operate air pump	2.00
Average rate of combustion, coal per square foot of grate per hour	4.9 lbs.

ECONOMY OF ENGINE.

Cut-off high cylinder, not including clearance	0.22
Total ratio of expansion including clearance	15.7
Steam per hour per indicated horse power steam cylinder including jacket consumption	13.64 lbs.

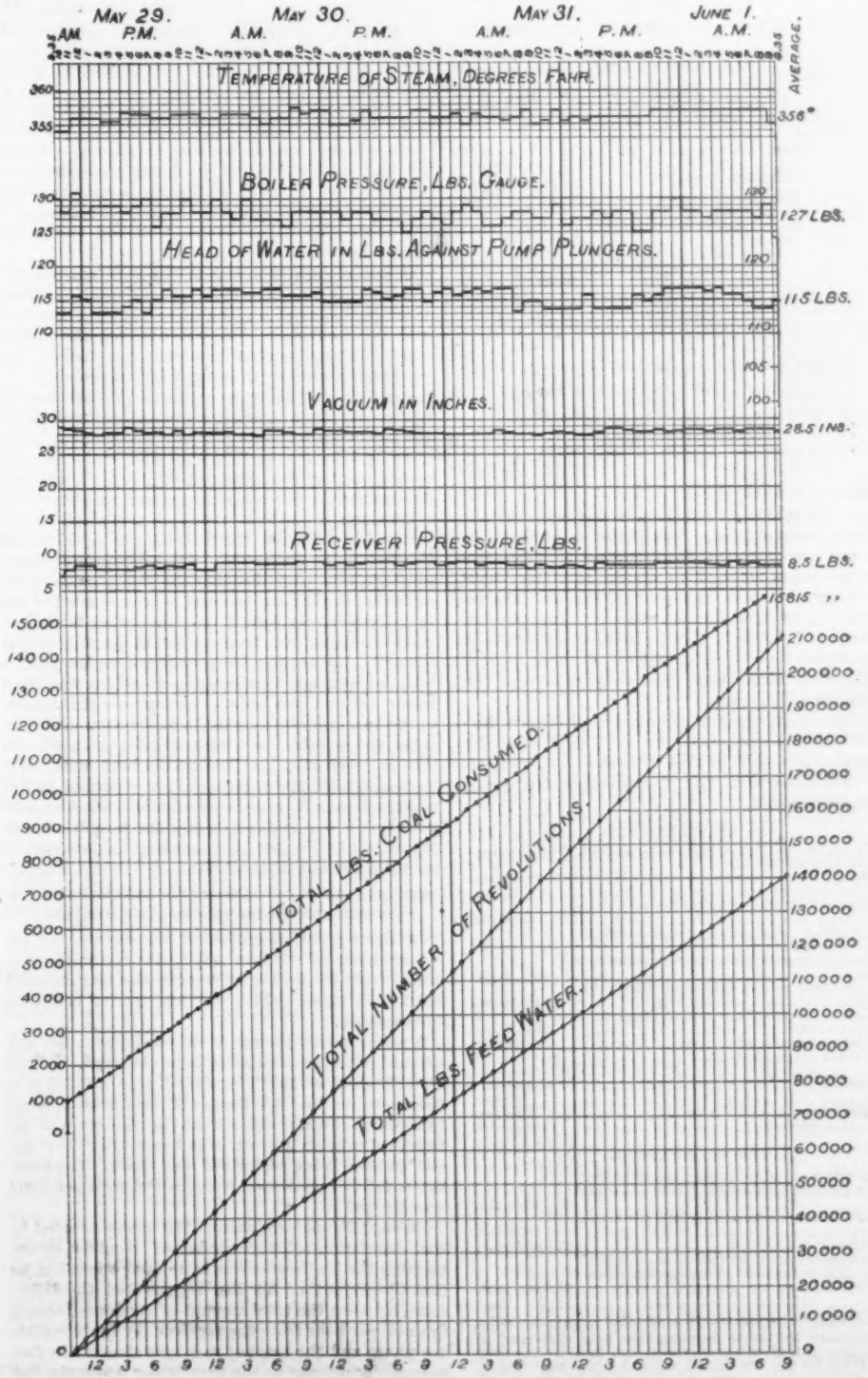


Fig. 23.—Log of 72 Hours' Test, Pawtucket Pumping Engine.

This figure should be regarded subject to a possible error of 2 per cent. due to this limit of error affecting the determination of horse-power from indicator ends.

British thermal units per minute per horse power	254.4 lbs.
Efficiency of mechanism of engine and pump	96.4 per cent.
Steam accounted for by indicator at cut-off high cylinder total consumption equal unity	67.0 per cent.

ECONOMY OF BOILER.

Water evaporated per pound of fuel from 102 degrees into steam at 125 lbs. pressure.	8.88 lbs.
Equivalent evaporation from and at 212 degrees per pound of combustible	12.12 lbs.

ECONOMY OF ENGINE AND BOILER COMBINED.

Duty per 100 lbs. of coal at actual efficiency of boiler	12472000 ft. lbs.
Coal per hour per indicated horse power steam cylinders	1.54 lbs.

ECONOMY OF ENGINE AND BOILERS COMBINED.

If boilers had evaporated 10 lbs. of water into steam from actual temperature of feed.

Duty per 100 lbs. of coal	140430000 ft. lbs.
Coal per hour per indicated horse power cylinders	1.37 lbs.

CHECK UPON MEASUREMENT OF FEED WATER.

72-hour Test.

By Measurement of Heat Exhausted or Rejected at Air Pump of Engine.

The heat which entered the engine per hour was as follows:

1,958 lbs. of feed water, to each pound of which there were supplied 1.221 heat units, the total heat of evaporation. Hence

	Heat units.
Heat given to steam — 1,958 × 1,221	2,390,718
The chimney heater evaporates 38 lbs. of water at 225 degrees in steam at 22 lbs. pressure, making 38 × 960	36,480
Total heat received by engine	2,427,198
This heat is distributed as follows:	
58,351 lbs of condensing water is raised in tempreature from 63.0 to 92.1 degrees F., making	1,698,014
118 lbs. of the feed water is blown to waste from the receiver, representing 118 × 225	26,530
107 lbs. of the feed water is drained from the jackets, representing 107 × 310	33,570
The remainder of the feed water, or 1,958 — 118 — 107 = 1,733 lbs., is found in the hot well representing 1,733 × 92.1	159,609
The indicated work performed or 143.49 H. P. represents $\frac{143.49 \times 1,980,000}{772}$	368,709
The estimated radiation is 20 lbs. of steam per hour	38,320
	2,324,412
Balance unaccounted for	103,776

This discrepancy represents 4 per cent. of the whole amount of heat. Part of this is ascribable to the leakage of steam from the safety valve and stuffing boxes referred to above, and the vapor which escaped from the vent *A*, Fig. 19. The remainder is due to undefined causes.* The error is, however, on the right side to make the feed-water measurement worthy of confidence as being slightly too large and unfavorable to an exaggeration of the economy of the engine.

The principal observations made half-hourly during the 72-hour test, are shown in Fig. 23, after the admirable plan used by Prof. Unwin in his report on the performance of the Worthington high-duty pump in England.

II. Bituminous Test.

All data for this test are the same except the following:

Revolutions per minute	49.44
Average boiler pressure	128 lbs.
Average water pressure against pumps	116 lbs.
Average cut-off high cylinder not including clearance	0.235 lbs.
Total ratio of expansion by volume including clearance	14.8
Average indicated horse power steam cylinder	147.95 lbs.
Average horse power indicated pump cylinder	140.74 lbs.
Average horse power devoted to friction	7.21
Duration of test	24.13 hours
Total bituminous coal	5,200 lbs.
Total wood = 4-10 × 200	80
Total	5,280 lbs.
Ashes	510 lbs.
Fuel per hour	218.6 lbs.
Feed water per hour	2,046 lbs.

ECONOMY OF ENGINE.

Steam per hour per indicated horse power steam cylinders, including jacket consumption	13.82 lbs.
British thermal units per minute per horse power	257.7 lbs.
Efficiency of mechanism	95.1 per cent.
Steam accounted for by indicator at cut-off high cylinder total consumption equal unity	67.5 per cent.

* Most careful determinations of heat exhausted from engines make the latter *less* than the heat delivered to the engine. Mr. Hirn has ascribed this fact to the heat carried off by the air mixed with the hot well water. Such escape of heat corresponds to that passing off through the vent *A*, Fig. 19.

ECONOMY OF BOILER.

Water evaporated per pound of fuel from 104° into steam at 126 lbs	9.35 lbs.
Water evaporated per pound combustible from and at 212 lbs	12.11 lbs.

ECONOMY OF ENGINE AND BOILER COMBINED.

Duty per 100 lbs. of coal at actual efficiency of boilers	127,350,000 Fx lbs.
al per hour per indicated horse power steam cylinders	1.48 lbs.

ECONOMY OF ENGINE AND BOILER COMBINED.

If boilers had evaporated 10 lbs. of water per pound of coal from temperature of 102 degrees.

Duty per 100 lbs. of coal	145,041,000 Fx lbs.
Coal per hour per indicated horse power steam cylinders	1.30 lbs.

By reference to subsequent remarks on the theoretical heating capacity of the two kinds of coal it will be seen that the increase of duty with the bituminous coal was not as great as chemical anlalysis indicates should have been the case.

MEASUREMENTS OF STEAM JACKET CONSUMPTION.

The jackets consist of an annular space about two inches deep, enveloping both the heads and sides of the cylinders. Outside of the jackets is a covering of fossil meal about one inch in thickness. Over this is a lagging of sheet iron painted straw color. The jackets are drained by a pump worked from the engine. This pump has a displacement about three times the volume of the water condensed by the jackets.

During preliminary tests made previous to the 72-hour test, the steam condensed by the jackets of both cylinders was determined as follows: the trap or well into which the condensed steam from the jackets was led on its way to the jacket pump was connected with a portable surface condenser, and the connection between this well and the jacket pump was closed.

A water glass attached to the well enabled the condensed water to be maintained therein at a fixed level by means of a globe valve between the well and the condenser. The water leaving the surface condenser was received in a barrel on scales. The condensing water was gauged by maintaining it at a constant level above an orifice and calibrating the latter. By these arrangements a measurement of the jacket condensation for two consecutive hours gave 108.5 lbs. for the first hour and 106 lbs. for the second hour, or an average of 107¼ lbs. It was also determined, by the temperature and weight of the condensing water, that the heat contained in the water drained from the jackets was equal to 310 thermal units per pound. The conditions of steam pressure, etc., were the same for this measurement as during the 72-hour test and 24-hour test when the jacket water was forced into the boiler feed pipe, thereby raising the temperature of the feed water from 92.1°, the average temperature of the hot well, to 104°, the average temperature at which the feed water entered the boilers—an increase of 11.9°, due to the heat contained in the jacket water. If we assume the weight of the latter at 107¼ lbs. per hour, this increase of temperature of the feed water corresponds to 308 thermal units per pound of jacket water. Hence it may be concluded that the consumption of the jackets during the long trials was practically 107 lbs. per hour, or about 5½ per cent. of the total steam consumption.

DETERMINATION OF CONDENSED STEAM FROM RECEIVER RE-EVAPORATED BY FLUE HEATER.

In the regular operation of the engine, the receiver must be "blown out" into the waste pipe about every 2½ hours, to remove the accumulated condensed steam which the flue heater is unable to evaporate.

A water glass attached to the receiver enables the amount of the accumulation to be observed. A hose was attached to the "blow-out" pipe and led to a barrel on scales. By means of this arrangement the weight of water taken from the receiver was determined over an interval of 24 hours, the "blowing-out" process being performed nine times. The average weight of condensed water withdrawn per hour was 118 lbs.

During this determination the pump devoted to the circulation of the condensed receiver steam through the flue heater was in regular operation, so that the weight of 118 lbs. represented the difference between the total amount of condensed steam drained per hour from the receiver by the circulating pump and the amount re-evaporated by the flue heater. To determine the two latter amounts, the circulating pump was disconnected, and the receiver water allowed to run out of a valve regulated by hand, so as to maintain a constant level of water in the receiver, the least height of water that could be visible in the water glass being thus maintained.* The water thus collected was weighed for an interval of eight hours, and the amount per hour, or 156 lbs., was taken to represent the total water circulated by the receiver pump. The difference of the above figures gives 38 lbs. as the water evaporated by the flue heater per hour. The capacity of the circulating pump was twice the volume of the 156 lbs. of water. The pump was located some 10 in. below the receiver and bottom of water glass on the latter.

The water glass showed *no* water until over two hours after each "blowing out," the entire accumulation occurring in a very short time. These facts make it probable that the pump delivered the whole 156 lbs. of water per hour into the flue heater, until the latter overflowed, *after which* the accumulation in the receiver occurred. The flue heater consisted of a rectangular mass of piping about 2 ft. square and 7 ft. long, composed of 220 ft. of 2-in. wrought-iron pipe fastened into cast-iron manifolds. The total surface was about 150 sq. ft. The fall of temperature of the chimney gases between points in the flue, immediately before and about 8 ft. beyond the location of the heater, was from 428° to 354°, or 74° F. The weight of gases per pound of coal will be shown under the head of Heating Capacity of Fuel, to be 21 lbs. Taking the specific heat at 0.24, and the coal consumed per hour at 220 lbs., the heat represented by the 74° of fall is

$$21 \times 74 \times 0.24 \times 220 = 90{,}000 \text{ thermal units.}$$

The mean pressure in the heater was that of the receiver, or about 8½ lbs. above the atmosphere. To evaporate 38 lbs. at this pressure and to heat 156 lbs. through, say, 10° loss of temperature, due to traversing the pump passages, etc., requires about 38,000 thermal units. The radiating surface in the flue between the two thermometers was roundly 150 sq. ft., which was of sheet iron lined with one thickness of brick. Such a surface might, according to Peclet, lose 1.5 heat unit per hour per degree difference of temperature.

The latter was roughly determined to average 200° F. Hence the loss by radiation might be

$$1.5 \times 150 \times 200 = 45{,}000 \text{ thermal units.}$$

The total loss might therefore be:

Thermal units:

38,000 absorbed by water evaporated in heater.
45,000 lost by radiation.

83,000 total loss by estimate of radiation.
90,000 total loss by estimate of chimney gase .

7,000 discrepancy.

The discrepancy,† while not entirely satisfactory, is sufficiently so to serve as an approximate verification of the figure for water evaporated by heater given above, namely, 38 lbs. per hour, or about 2 per cent. of the total steam consumption of the engine.

ECONOMICAL VALUE OF FLUE HEATER.

Assuming the effect of the heater to be the addition of about 40 lbs. of steam to the volume of the latter which remains vaporous at the end of admission to the low cylinder, the useful effect would be that due to increasing the admission pressure of the low card. In round numbers the steam remaining vaporous at low cut off represents 1,600 lbs. per hour. The addition of 40 lbs. would increase the pressure $\frac{40}{1600} = \frac{1}{40}$. The absolute pressure averages 22 lbs.

Hence the increase of average pressure during admission would be less than $\frac{6}{10}$‡ lbs. per sq. in.

The gain in mean effective pressure due to such an increment would represent about 1 per cent. of the total power of the engine.

CONDITION OF ENGINES AND BOILERS.

The engine was placed successively on the several dead centres and the leakage of the inlet valves and

*This experiment was made after the 72-hour and 24-hour tests, so as not to interfere with regular conditions during these tests.

† A similar discrepancy appears in the data of the action of the feed heater in the test of the Boston sewage engines.

Vide Peabody's Thermodynamics.

‡ The change of receiver pressure or difference shown by indicator cards when the heater was thrown out neither denies nor confirms this figure.

pistons noted by observing the escape of steam from the proper indicator cocks. The greatest leakage was measured by attaching a hose and leading the steam into a condenser. From this experiment the leakage in the other cases was estimated by the eye.

		Leak through Inlet Valve.		*Leak through Piston Rings.*
Low Cyl.,	H. E....	6 lbs. per hr. by	exp't.	2 lbs. by estim.
" "	C. E....	2 " " " "	estim.	4 " " "
High "	H. E....	2 " " " "	"	6 " " "
" "	C. E....	1 " " " "	"	0 " " "

The exhaust valves could not be conveniently tested.

Two of the safety valves leaked slightly, but it was not considered judicious to stir them.

A slight but steady leakage was present at the high cylinder piston rod and at the plunger of the jacket circulating pump. No allowances are made for these leaks in the figures given for steam consumption.

COMPARISON OF PRESSURE MEASUREMENTS AND TEST OF PRESSURE GAUGES AND INDICATOR SPRINGS.

The Ashcroft Manufacturing Company kindly loaned me for this work six of the latest designs of the Tabor Indicator, which were sent direct from their factory to the pumping station. Four of these indicators were fitted with springs standardized for use under cold-water pressure, and the remaining two, together with a pair from the writer's cabinet, contained springs standardized for steam contact The indicators with water springs were tested on an Ashcroft Gauge Tester.

The latter belonged to the pumping station and consisted of a tube filled with glycerine to one end of which the instrument to be tested could be attached, while at the other end a known pressure can be produced by loading a piston with weights. The piston has an area of 0.248 sq. in., and weights were provided corresponding to each 5 lbs. pressure per square inch. I found these weights in accurate condition, and that the water springs of the indicators agreed with the testing apparatus and with each other, and with the pressure gauge from which were read the water pressure against the pumps—within 1 lb. sq. in., which was the limit of accuracy of the testing apparatus.

The gauge in the engine room from which the boiler pressures were read was also tested on the Ashcroft Tester, with the following results:

Reading of Gauge.	*Reading of Standard.*
32½ lbs. per sq. in.	30 lbs. per sq. in.
57 " "	55 " "
82 " "	80 " "
107½ " "	105 " "
123 " "	120 " "
128 " "	125 " "

Now, this gauge is attached to the vertical portion of the steam supply pipe in such a position that there is a column of condensed steam 4.62 ft. in height which interposes its weight between the mechanism of the gauge and the boiler pressure. The gauge, therefore, fails to receive the full steam pressure by the weight of the 4.62 ft. of water, which amounts to 1.98 lbs. per sq. in. Calling this 2 lbs. and applying it as a correction to the above figures, it appears that—

When gauge reads	30½,	true boiler pressure is	30 lbs.		
"	"	55	"	"	55 "
"	"	80	"	"	80 "
"	"	105½	"	"	105 "
"	"	121	"	"	120 "
"	"	126	"	"	125 "

The discrepancies are all within the limit of error of the testing apparatus.

Mr. Walker, the chief engineer, had informed me that he had adjusted the gauge for the effect of the water column, and I give the above detailed account as an excellent illustration of the skillful accuracy with which the details of the pumping station are maintained by this gentleman's self-acquired expertness and knowledge of mechanical measurements and computations.

The steam springs of the indicators were tested by using the different indicators and springs at the same cylinder cock, at times when the conditions of boiler, receiver, and vacuum pressures were the same. The fact that they all agreed with each other, and that two of them were directly from the hands of a standard manufacturer, was considered sufficient assurance of their accuracy.

The vacuum gauge was not tested. The average vacuum was 28½ ins., the average barometer reading 30 ins., and the average back pressure in the low-pressure cylinder 1¼ lbs. per sq. in. or 2.50 ins. of mercury. These figures make the back pressure due to imperfect vacuum 30 — 28½ = 0.76 lbs. per sq. in., and that due to forcing steam out of cylinder 0.49 lbs. per sq. in.

There is, therefore, no occasion to regard the vacuum gauge as possessing any error of practical importance.

The suction pressure against the pump was shown by a float, which gave the feet of height through which the water was lifted from the well.*

This height averaged 13.35 ft. The temperature of the water lifted averaged 63.6° F. Hence the suction pressure was 5.78 lbs. per sq. in.

The suction pressure was also measured by a vacuum gauge connected to the pump chamber at the centre of the latter's height. The average suction pressure by this gauge was 5.65 lbs. per sq. in.

In the 72 hour test the average pressure shown by the water pressure gauge, *K* Fig. 17, connected at the discharge pipe at a point between the pump chamber and the main foot or check valve, was 109.69 lbs. per sq. in., reduced to the level of the centre of pump pistons. Adding this to the average of the two figures for suction pressure, given above, we have the total head pumped against, as determined by pressure gauges, equal to 115.4 lbs. per sq. in. This pressure should be *less* than the mean effective pressure shown by the pump indicator cards by an amount equal to the force required to work the pump valves. But the mean effective pressure shown by the pump indicator cards was from 114.7 to 115 lbs. per sq. in. This paradoxical discrepancy was apparent early in the test, and was made the subject of the most careful study. But while the errors involved in calibration of gauges and springs, and the fact that the very fine scale of 100 had to be used for the pump cards, may allow the discrepancy between the two figures to be set aside, *there is still no surplus to represent any sensible loss of pressure due to working the valves.* In the calculations of pump horse power and duty, I have used the mean of the pressures deduced from the gauges and indicators respectively.

The design of the pump valves is quite consistent with the absence of any practical difference of pressure between the interior of the pump cylinder and the delivery main. The successful principle introduced by H. R. WORTHINGTON in 1850, of using a large number of small valves, has an almost perfect realization in the Pawtucket pump, Corliss having reduced the inertia of the moving parts of the valve to a minimum.

The details of one of the valves are shown in Figs. 24 and 25. In Fig. 24 the disc of copper forming the valve is shown lifted off of the valve seat $\frac{1}{10}$ in., about the extent which the valves are believed* to lift during the working of the pump. The area exposed to pressure tending to open the valve is 1.8 sq. in. There are 70 valves in each section of the pump. A lift of $\frac{1}{10}$ in., therefore, offers an area of outlet equal to half the cross section of the pump plunger. The weight of the moving parts of each valve is 0.8 oz. To lift a valve $\frac{1}{10}$ in., and maintain it against the compressive force of the spring, requires a water pressure of ¼ lb. per sq. in. To overcome the inertia of the valve would require less than ¼ lb. of water pressure, supposing the valve to open during the first fifth of an inch of piston travel, or during $\frac{1}{240}$ of a second of time. To accelerate the weight of water delivered per stroke requires a pressure of $\frac{5}{10}$ lbs. per sq. in. It will be shown in discussing the fly wheel that the variation of speed of rotation due to inequality between the constant water resistance and the variable steam pressure cannot exceed one eighth of one per cent.

These facts make it evident that any irregularities of figure in the pump diagram which exceed about 1 lb. per sq. in. are due solely to vibrations of the springs of the indicators, and that it is quite reasonable to find that any difference between the mean pressure in the pump cylinders and the pressure in the delivery main is within the limit of error of the pressure measurements, or 1 lb. per sq. in. A weir† measurement of the delivery of the pump made during its early history when the plungers may be assumed to have been tight, showed a "slip" slightly less than two per cent.

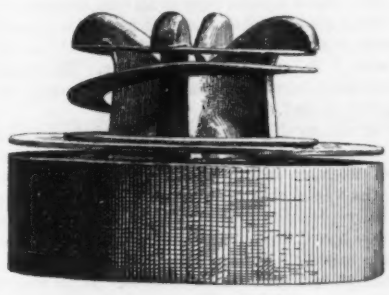
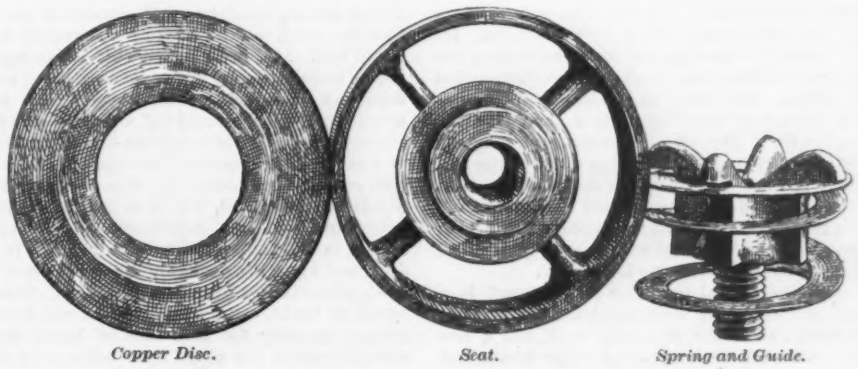


Fig. 24.—Complete Pump Valve, Pawtucket Pumping Engine.



Copper Disc. *Seat.* *Spring and Guide.*

Fig. 25.—Parts of Pump Valve, Pawtucket Pumping Engine.

* A scale model of the pump, which can be worked by hand, enables the action of the valves to be observed through glass partition. The estimate of amount of lift is made from this mode.

† London *Eng'g*, 1879, page 189.

Oil Fuel in Marine Practice.

The use of crude oil under boilers for generating steam is by no means a new process, oil having been burned for this purpose in various ways ever since the early days of the Pennsylvania oil fields. The number of burners and apparatus invented and tried for oil under boilers is very large. Nearly all of them have been rather complicated, requiring a system of coils or retorts to heat before it is burned or have depended upon the use of steam to spray the oil under the boilers.

The disadvantages of the retort system are the inherent danger of fires and explosions from the hot and confined oil. Spraying the oil by the use of a steam-jet requires the use of a very considerable

amount of steam, whose introduction into the boiler furnace exerts a marked influence in cooling the furnace gases, and lessening thus the evaporative duty of the fuel.

On the Caspian Sea and the Volga River a large fleet of steamers using petroleum fuel has been in service for four years. The oil in these furnaces is sprayed by a steam-jet, whose uneconomical performance has been a matter of little moment, because until within a short time the wells of the Caspian region have produced more oil than could be sold at any price.

The Aerated Fuel Company's system of burning crude petroleum, described in our issue of Nov. 30, 1889, uses neither heating retorts nor a steam-jet in its furnaces, but uses compressed air to spray the crude petroleum, thus burning the fuel with the least possible "air excess" and without the introduction of moisture into the furnace. The system has been in satisfactory use under stationary boilers for two years or more.

Of course the economy in the use of petroleum would be much less marked in this country than on the Caspian Sea, where coal was dear and petroleum cost little or nothing. Nevertheless it is claimed that for marine practice especially, a considerable saving can be effected here by the substitution of oil fuel for coal. It is a matter worth consideration, as there seems no immediate prospect of a diminution of our own available supply of crude petroleum.

As regards the matter of fuel economy alone, the Aerated Fuel Company state that a little less than 3½ bbls. of oil burned by their system is equivalent in heating power to 2000 lbs. of good steam coal. Oil can be bought on the Eastern seaboard at 2 cts. per gall.; hence at this price it costs no more than coal at $2.80 per ton. But other conveniences and economies in use are of more importance than the first cost of the fuel. The crude oil necessary for a given run weighs little more than half as much as the coal required for the same run. It occupies less than half the bulk, and with the Aerated Fuel Company's system it is stored in closed tanks below the level of the furnace, thus leaving the space usually occupied by the coal bunkers available for freight.

The handling of coal and ashes on shipboard is a difficult and expensive work, requiring a large number of hands, since the men can work but a few hours at a time in the heat of the boiler room; and since a force of "trimmers" and "passers" is required in addition to the stokers. With oil, however, the whole labor of handling the fuel is done by pumps, and the oil spray in the furnace is regulated by the mere turn of a valve.

Other points to be considered are the increased power of the boilers, amounting in some cases to a gain of one-third in the rate of evaporation over what is possible with coal; the saving in the expense of getting the oil fuel on board; and it is claimed, a considerably increased durability of the boiler and appurtenances.

Probably the first question that occurs to every one in considering the use of oil on shipboard is: Can it be made safe? If this matter be not definitely settled, then the question of a gain in economy by its use will hardly be deemed worth discussion. The risk of fire on shipboard should not be increased under any pretext whatever.

The system of the Aerated Fuel Company seems to offer as much safety from fire as can be secured, with the use of oil fuel. The oil supply is all stored below the level of the furnace in closed iron tanks and is pumped up to the burners instead of being fed by gravity; or it may be forced up, without using a pump, by the air pressure alone; so that the moment this pressure is let off, the fire goes out and the oil falls back into the storage tank in the bottom of the ship. Hence, any failure or leak would not cause oil to flow into the furnace. The oil may be stored as far as desired from the furnace and shut away as completely as desired from other parts of the ship.

Whether it would be possible, however, to so arrange the whole apparatus that it would be so absolutely safe as coal, is a matter which cannot be decided without careful inspection of the actual plans of a working plant. The points of danger would lie in the possible leakage of the oil from some seam in the tanks or pipes, or from the connections used in loading. Crude oil, too, is apt to give off vapors which are highly explosive when mixed with air in the right proportions. Oil prepared by a cheap process of partial distillation, by which the more volatile parts of the crude oil only are driven off, is much safer, but is apt to give some trouble in pumping in cold weather, and if sometime a foolhardy engineer should think it necessary to warm up the oil pipes or pump with a torch, there might be worse trouble.

However, it may be quite possible to so arrange the whole plant that it would be as safe as coal; and the economy which is promised by its use enough for the task to be well worth trying.

A place where oil fuel would be of the greatest service, and where we look to see it introduced, even if some slight risk should be found to be unavoidable, is on torpedo boats and fast cruisers. Here the matter of economy is far subordinate to the saving in weight and space. Oil fuel would save one-half in these particulars over coal, or a quantity could be carried sufficient to last for a cruise of double the length. The increased capacity of the boilers and the ability to increase it still further in an emergency by an increase in the air pressure on the burners might make the difference between capture or escape.

The clean and intensely hot flame offers advantages in the construction of boilers of special design, which should be considered by naval inventors. Still another advantage of liquid fuel would be the ability to shut off the fires entirely when not under steam, and still get up steam in a few minutes in case of emergency. It is to be remembered that America is as yet the only country, with the exception of Russia, which has such supplies of petroleum that she could venture to equip war vessels to burn liquid fuel. It is to be hoped this advantage may not be lost sight of by our naval engineers; the only drawback to it being that a vessel on a foreign cruise could hardly "coal up" with oil very often.

Since the above was in type we find in *Engineering*, of Jan. 10, an interesting description of a torpedo boat recently completed by Wm. Doxford & Sons, Sunderland, England, which is fitted for burning petroleum fuel. The *Sunderland*, as she has been named, is 137 ft. long, 13 ft. 9 ins. beam, 9 ft. 3 ins. deep, and 4 ft. 2 ins. draught. She is built of mild steel, galvanized, with a double bottom, forming a series of tanks, eight in number, in which there is storage capacity for 13.82 tons of liquid fuel, or enough to drive the vessel 1,800 miles at a 10-knot speed. The arangement is such that any one tank can be emptied separately, or the supply can be drawn from all uniformly. While these tanks are intended for the liquid fuel, they can be used, in case of necessity, for water ballast. A small Worthington pump is set in the stokehold for supplying the fuel to the burners, and by a change in the connections it may be used to fill the fuel tanks from a vessel alongside.

The engines are triple expansion, of about the usual type of torpedo boat engines, but with extra large rubbing surfaces throughout. The cylinders are 15 ins., 22 ins., and 33½ ins. in diameter, by 18 ins. stroke. Arrangements for lubricating include the use of sight feed cups wherever possible, and some special devices for cylinder lubrication. The thrust block has a series of 12 rings, each faced with Parson's white metal. Each ring has a separate sight feed cup and oil valve, similar to those on the cylinders. The thrust is transmitted direct to the main bed-plate of the engine, and is distributed to five of the vessel's floors. The three-bladed propeller is 6 ft. in diameter and 8 ft. 3 ins. mean pitch, and is made of solid cast steel.

The chief interest in the vessel centers in the appliances for burning the petroleum fuel. This is pumped by the Worthington pump before mentioned from the storage tanks to a small cylindrical tank near the side of the vessel, where it is placed under an air pressure of about 35 lbs. per sq. in. Besides this tank there are four tanks for holding compressed air, which are kept charged by an air compressor in the stokehold. At the burner the oil jet is sprayed by compressed air from these tanks in a similar manner to the Aerated Fuel Company's system referred to above. Each burner, when operated alone, gives a flame about 6 ft. long and 9 ins. in diameter. The combined jets fill the fire-box with a mass of flame, which gives off neither smoke, smell, nor sparks, and, therefore, is peculiarly suitable for naval use. Each burner uses from 25 lbs. to 75 lbs. of oil per hour, according to the pressure carried, and cocks are arranged to permit the turning off of any individual burner, or of all of them, at once when desired.

A forced draught fan is set in the stokehold, and produces an air pressure in the furnace equal to 6½ ins. of water.

The boiler is of the ordinary locomotive type, with four hundred and nineteen 2-in. tubes, 9 ft. in length. The total heating surface is 2,173.8 sq. ft., and the steam capacity is 305 cu. ft. The oil burners are set in the furnace front, and are 31 in number. The protection which the builders have found it necessary to give the furnace plates, on account of the high temperature of the furnace, has resulted in the entire prevention of leakage at tubes and rivets, which has of late given such serious trouble in forced draught boilers.

The *Sunderland* has been under test for some months, and has shown some excellent records. She has made a speed of 22.5 knots with 1,220 I. H. P., the engines making 354 revolutions per minute. The slip per cent. of the propeller was 26.6, and the displacement was 84 tons. The thrust, calculated from the I. H. P., was 13,676 lbs. The boiler pressure was 158 lbs., the pressure in the first receiver was 70 lbs., the pressure in the second receiver was 15 lbs., the vacuum was 24 ins. The feed water had a temperature of 125°, the compressed air pressure was 35 lbs., the oil pressure was 30 lbs. and the pressure of the forced draught was 6¼ ins. of water. At this time only 21 burners were in use and 10 burners were in reserve, so it is apparent that as far as the furnace was concerned the vessel could have much bettered her performance.

No very exact figures regarding fuel consumption have been given, but on a recent test, at a speed of 20 knots, with a development of 1,000 H. P., the fuel used was 1 lb. per I. H. P. per hour. The makers are confident, however, that they can greatly improve this record.

One of the most gratifying results of the tests has been the facility with which the fire can be controlled without injury to the boilers. Recently, while the vessel was running at 21 knots per hour, with the representatives of several foreign governments on board, the engine was stopped. The burners were instantly shut off, and the steam did not rise enough to lift the safety valves. There was no sign of leakage of tubes at the time, nor of dampness in the furnace, when it was examined on the following day.

Besides the more manifest advantages of oil fuel as outlined above, other excellent features have been shown by the tests. As already stated, the oil burned with compressed air produces a flame perfectly free from smoke, sparks or odor. The advantage of this will be apparent to any naval officer. The success of a torpedo boat generally depends on her ability to reach a point in close proximity to the ship which she desires to destroy before she is discovered. With oil fuel there will be neither smoke by day or sparks by night to give warning to the enemy.

As already stated, the full capacity of the boat's tank is enough to enable her to make an 1,800-mile run at a 10-knot speed. But even this can be increased by taking extra oil on board in casks, as a torpedo-boat, using coal, takes an extra supply in sacks, when making a long run. The increased stability due to the fact that the fuel acts as ballast and is stored in the lowest part of the vessel is of much importance, in view of the recent capsizing of two French torpedo boats. Moreover, the increased stability allows the designer greater latitude in arranging guns and machinery than is ordinarily the case.

With regard to further claims made by the makers of the vessel, we reprint the following from *Engineering*:

> In manœuvring under steam it may be often desirable to stop suddenly and lay by for a greater or less time—perhaps a few minutes, perhaps an hour or more—and to be ready to go on at full speed at a second's notice. The difficulty of effecting this with a coal fire is well known to every engineer and naval officer. If the fire be kept at full capacity, with the fan running hard, it is difficult to get rid of the steam, in addition to which coal fires can only be kept in good order for a limited time. If a considerable portion of that time be spent in waiting for an opportunity to act, when the opportunity arrives the fire may be in such a bad condition that steam cannot be kept up. If, on the other hand, the fire be let down, it cannot be got into condition again until some time has

elapsed. With liquid fuel, however, any number of burners may be put out of use instantly, and may be lit again as quickly. Thus, if the boat were running at a speed of 21 knots per hour, and were stopped suddenly, half or three-quarters of the burners could be put out, only sufficient being kept alight to maintain the steam at the maximum working pressure without lifting the safety valves

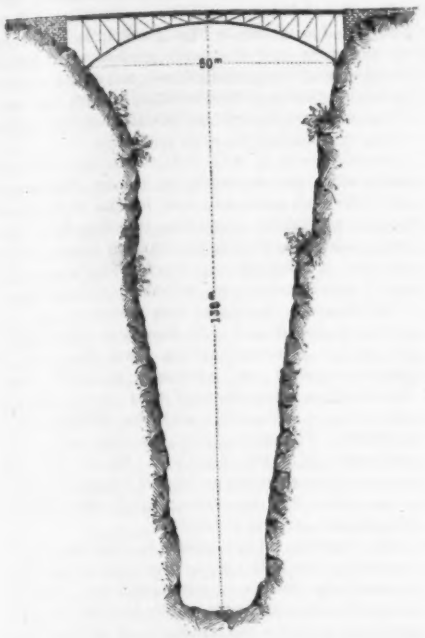


Fig. 1.- The St. Guistina Viaduct, Southern Tyrol.

On the order being given to go ahead the other burners would be lit and the pressure of steam thus maintained. In fact, it may be said that once steam reaches any required tension—maximum or otherwise—it may be kept at that tension so long as the fuel supply lasts, no matter whether the boat be kept running all the time, or whether she be intermittently stopped and started for any intervals, uncertain or otherwise.

The arrangement of the furnace is such that steam may be raised and lowered as suddenly as possible without causing leakage to the tubes or other parts of the boiler. In other respects the boiler is not subject to the well-known causes of deterioration which are consequent upon using coal in a furnace. In fact, the life of the boiler ceases to be in this vessel a measure of the life of the boat. In most torpedo craft the boiler may be expected to give out first and is the source of the greatest anxiety. With this system of firing such is not the case. It may be noticed in passing that in order to increase the durability of the engine, to bring it nearer to that of the boiler, increased bearing surfaces have been given to all rubbing parts. For the same reason adjustable bearings have been fitted to all parts so as to take up in case of wear. In short, a higher efficiency of boiler with regard to durability has called forth a higher efficiency of engine (in the same respect) than has hitherto been considered necessary for such vessels.

With this system stokers are of course unnecessary. One man is more than sufficient to attend to the burners; he has nothing to do after the furnace is once put in operation. The fact that the system is automatic would doubtless be a great benefit in action. The advantage of not having to stoke, when steaming in a heavy sea, especially a beam sea, will be apparent. There is, of course, no coal-trimming required, and the advantage of perfect cleanliness is obvious. The boat can be kept as clean on deck as a sailing yacht. The sweeping of the boiler tubes is not required.

In conclusion, Messrs. Doxford maintain that the system of liquid fuel burning which they have adopted is the only one applicable to torpedo boats. This is in the main due to the fact that air is used in place of steam for the injection of the fuel. There are many systems of steam injection, but they are not suitable to torpedo boats on account of the loss of boiler water. Very large and heavy evaporators would be required to compensate for this loss, and they would be quite inadmissible on such boats.

THE SARNIA TUNNEL, under the St. Clair River, is now driven some 1,200 ft. at one end and 800 ft. at the other, and making progress at the rate of about 10½ ft. per day. At this rate, but little more than a year should be necessary to connect the headings.

The St. Guistina Viaduct over the Noce Schluct, in the Southern Tyrol.

(With inset.)

One of the most interesting bridges recently built in Europe, says a late issue of the *Zeitschrift des Oest. Ing. und Arch. Vereins*, is that at St. Guistina, Southern Tyrol, on the government highway now under construction from Cles to Dermulo. This bridge crosses the Noce Schluct, a chasm about 460 ft. deep and with almost vertical sides. See Fig. 1.

False works were of course out of the question; and the provincial government of Tyrol, which is building the bridge, invited proposals for plans for erecting on specifications giving the general data for the proposed structure. The government finally selected the plan of Mr. H. HAGEN, Chief Engineer of the Austrian Alpinen Montan Co., of Graz, Styria, a wealthy and well known firm of builders of all manner of engineering works.

The selected plan, here illustrated, is well adapted to the local conditions; it is an arch bridge, hinged at the springing points only. This "braced-spandril" type is convenient for erection without extra material, as it allows building out from the abutments to the center on the cantilever principle. It is rigidly connected at the center.

The span from center to center of springing points is 60 m., or nearly 200 ft.; the width of the bridge is 20 ft.; the two arched girders are 15 ft. apart between centers. The remaining dimensions are shown on the accompanying plans in metres. At each end of this main span, and connected with it by pins, is a plate girder, 13 ft. long, with one end resting on the masonry as shown in Fig. 2.

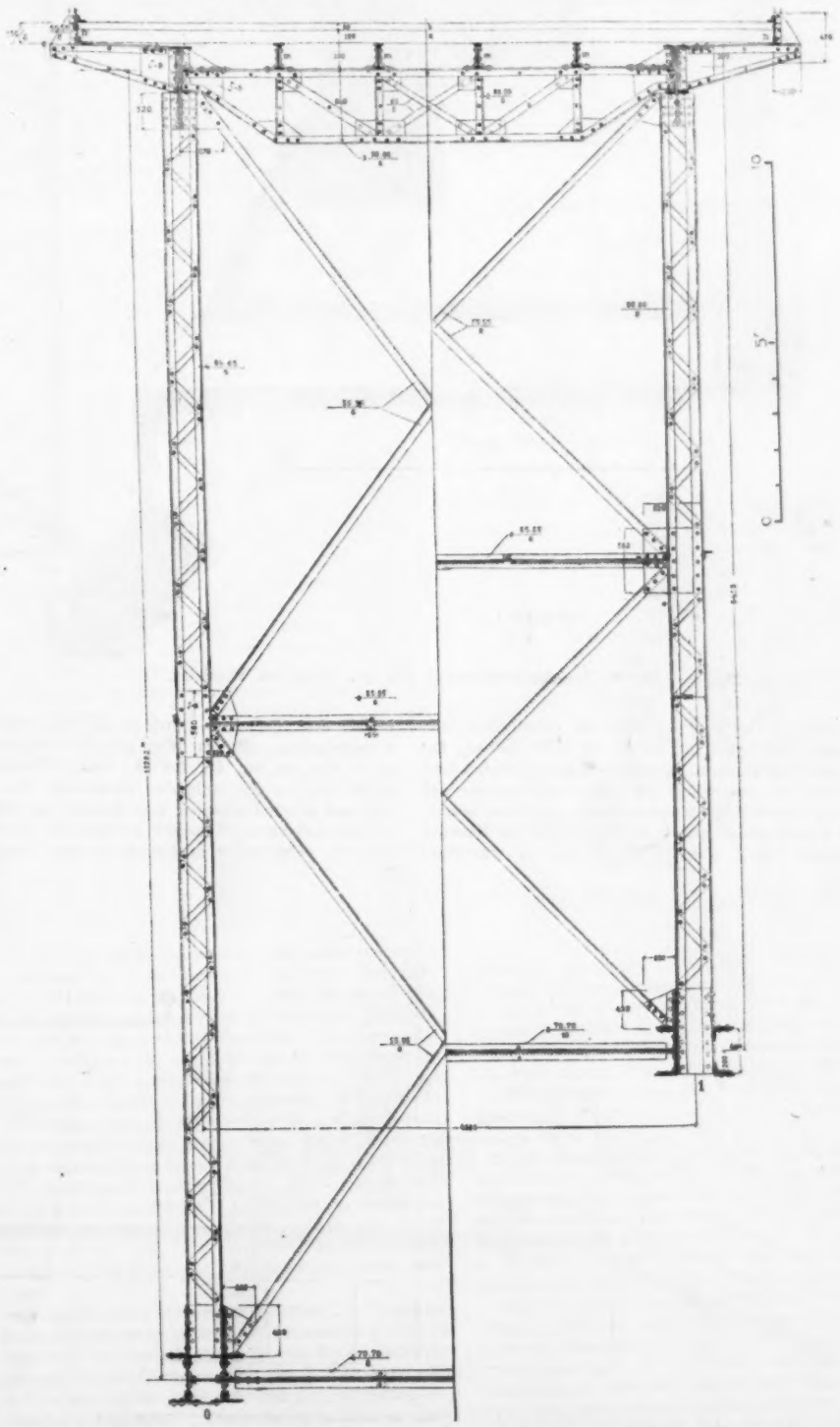


Fig. 4.—St. Guistina Viaduct. Sections of Arch and Roadway at Springing Line and about Midway towards the Crown.

The strains in the arch have been graphically determined as based upon the following data; (1) The weight of the floor system is taken as 21 lbs. per sq. ft. of bridge. (2) The weight of the iron is taken as equal to 800 lbs. per lineal foot

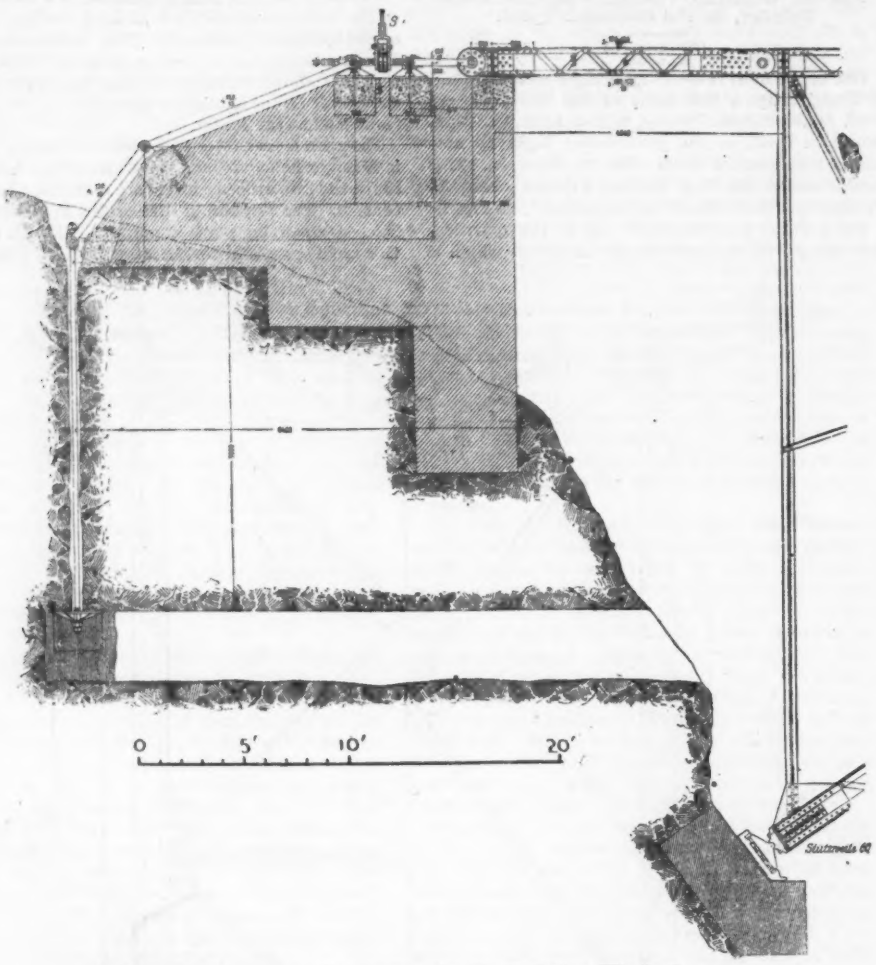


Fig. 2.—Anchorage of the St. Guistina Viaduct.

of bridge. The moving load for calculating the trusses was taken as equal to 96 lbs. per sq. ft.; in addition to this an assumed concentrated load of 5,600 lbs. per wheel on a four-wheeled car was used in proportioning the stringers and floor beams. The wagon gauge was 4 ft. 3 ins., and the distance between axles was 11 ft. 5 ins. A variation of 108 deg. Fahr. in temperature was taken into consideration. (4) The wind pressure was assumed at 31 lbs. per sq. ft., for the loaded bridge and at 50 lbs. for the unloaded structure. The area exposed to wind pressure was figured as equaling 1½ times the area of the side elevation of the bridge. (5) The permissible maximum strain throughout the whole structure was fixed at 11,400 lbs. per sq. in., reduced for compression members in accordance with the usual formula for columns. The total weight of wrought and cast iron in the bridge and two end spans was 210,000 lbs.

The structure was erected without false works, and the plans shown make the method so generally plain that a few supplementary remarks will suffice. After the abutments and the anchorages had been completed, as shown in Figs. 2 and 3, the end verticals of the arch and the plate girders were put into position, and the girders connected with the anchors by the adjusting screw bolts, shown in Fig. 3. These bolts regulated the position of the end verticals, and also of the arch members.

Starting now at both ends of the arch, the several parts were put together by means of a traveler, until the arch segments met in the center, where they were rigidly connected together by a closing piece fitted in between the two half-arches and then riveted. The bridge was erected in "the comparatively short time of two months and two days."

The finished structure was tested by a load of gravel so distributed as to represent a load of 96 lbs. per sq. ft. After remaining upon the bridge one hour this gravel was gradually removed. Careful observations taken showed that the elastic deflection at the middle of the arch was 0.0788 in. for both arch ribs. The permanent set was 0.24 in. for one arch and 0.28 in. for the other. All of these observations were made at as near the same temperature as possible. The tests being satisfactory, the bridge was at once opened to traffic.

The various views given in the inset and detached figures will enable the reader to study for himself the details of construction. It should be stated that a temporary cable passing over timber piers was used for the transport of certain material across the chasm; a platform suspended from two wheels, spaced about 7 ft. apart and running on the cables, was used for this purpose. The first panel out from the skewback was erected on false works, and traveling cranes and suspended platforms were also employed in the operation of erection.

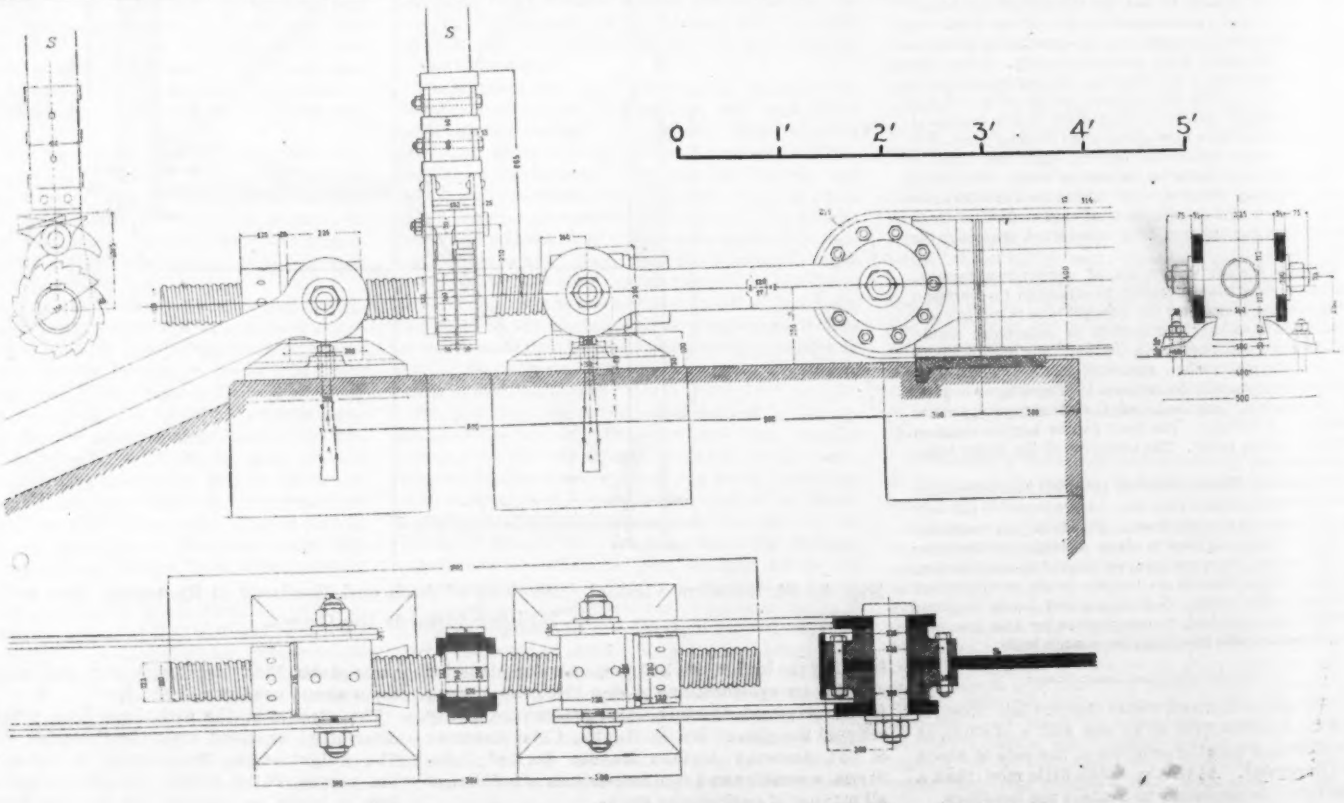


Fig. 3.—Adjusting Screws of Anchorage, St. Guistina Viaduct.

Steam on Street Railways in Italy.

A recent number of the *Centralblatt der Bauverwaltung* contains an article on the use of steam on street railways in Italy. The total length of tramways employing steam power in that country in July, 1884, was 1,031 miles; in 1888, it was 1,400 miles. Most of the lines are in upper Italy. The

longest line is from Bari to Barletta, a distance of 40.30 miles. The shortest line is 0.87 mile in length, and connects the station at Bergamo with a cable road. The average length of the lines is about 12.5 miles. The most of these lines are in the provinces of Milan and Turin, the city of Milan alone having six lines.

At a convention of street railway superintendents held lately at Milan, it was decided that trains of ten to twelve cars, making a train length of two hundred feet, were practicable and profitable. Speed on these railways is limited by law to 11.185 miles an hour, but the convention decided that this limit should be raised to 18.64 miles on highways where the traffic is slight.

The Street Cleaning Department of New York.

In the light of the recent change in the head of the Department charging with keeping clean the city of New York, the address of the late Commissioner, Mr. J. S. COLEMAN, delivered several months ago before the Brooklyn Institute, is interesting. The salient features to be considered, and the difficulties of the present organization, and some of the results obtained from Mr. COLEMAN'S standpoint, can be summarized as follows:

The New York law, creating the present department of street cleaning, was passed May 26, 1881. It was enacted to meet a general demand for a change in administration and methods. The bill was hurriedly drawn with the purpose of creating an independent department that would not conflict with other city departments having certain responsibilities in the care and maintenance of streets. Mr. COLEMAN says that herein lies the great inherent difficulty in performing good work in street cleaning. The Department itself is left without control over any of the many breakages of street surface resulting from repairs to pavements, laying pipes and conduits of all kinds, etc. He thinks that the present absurd division of authority and responsibility should be remedied, and that remedial legislative action has become a necessity. He concludes, on the basis of his eight year experience, that it would be better to abolish the present Street Cleaning Department altogether, and to make it a bureau either in the Department of Public Works or the Board of Health.

MR. COLEMAN says that the work of his department included the removal of about 1,500,000 cu. yds. of ashes and house refuse annually, or nearly one yard per inhabitant. To do this 2,000 men were employed. In the years 1881-1888, inclusive, the ashes and garbage collected amounted to nearly 11,000,000 cu. yds., and the street sweepings made about 3,000,000 cu. yds. more. To do this work the sum of $7,500,000 was expended. The roadways to be swept by the department aggregate 328.66 miles in length and an estimated superficial area of 7,000,000 sq. yds. In this area the more important streets are swept each day, and those in the residential and outlying regions once or twice a week. The whole street mileage of New York is 574.88, and from the whole of this the garbage is removed once each day.

For the economic supervision and efficient performance of this work the whole city is divided in four great districts, with Broadway and Fourteenth street as the main dividing lines. These districts are subdivided into precincts, with each district in charge of a superintendent, and each precinct in charge of a foreman; the latter has an assistant and a gang of laborers, carts, sweeping appliances, etc. The material collected in each precinct is taken by carts to dumping-boards located at convenient points along the East and North rivers, and from there by scows to the final place of deposit.

The garbage of hotels and large restaurants has a market value, and is sold to and removed by private parties without cost to the city. The removal of night soil is done under the direction of the Board of Health, and the matter collected from catch-basins is removed by the Dedartment of Public Works, which also removes incumbrances from streets and sidewalks and sprinkles the streets.

Every day 53 miles of streets are cleaned; three times a week 187 miles are cleaned; twice a week, 65 miles and 24 miles are cleaned when necessary. Besides the material collected by it, the Department also removes material received by permit at the dumping-boards, such as "boiler" ashes and trade refuse, the refuse of the public markets and matter which the Department of Public Works wishes to get rid of. The Street Cleaning Department removes all snow and ice from the streets.

Mr. COLEMAN says that bad pavements were his chief obstacles in the work of street cleaning; but aside from this there are other and serious impediments. To show the extent of the evils to be encountered by his department he quotes from his report of 1886 to show that in that year 98 miles of gas mains were laid; 25.58 miles of trenches opened for electrical subways; 47.91 miles of steam-pipe laid; 37.9 miles of salt-water pipes put down; 10,500 lin. ft. of double-rail track laid; 17,973 excavations made for house connections; 15.42 miles of water-pipe laid; 7.12 miles of sewers built; and many miles of excavations for repairs to water-pipes and sewers.

The difference in control and resulting conditions of cleanliness between New York and foreign cities was then pointed out, and the special point is made that in London and Paris the municipality alone can open the streets to get at underground pipes; no private individual or corporation can meddle with them.

The suggestion made by Mr. COLEMAN, that boys could be used instead of men in the daytime to keep the streets clean of refuse, etc., has the advantages of greater quickness of motion and less pay. The disadvantage, in the eyes of some individuals interested in city affairs, is that boys can't vote; a point doubtless appreciated but not mentioned by Mr. COLEMAN.

One of the chief sources of street dirt is the refuse carelessly thrown upon them by householders and others, in defiance of some rather antiquated and forceless ordinances. London imposes a fine, of not less than $25 and not exceeding $200, upon any person "sweeping or throwing any refuse, dirt, ashes, dust, decayed fruit, or offensive matter of any kind upon the foot or carriage way;" and further, in that city, "any person refusing to have the dust or ashes removed by the scavengers, or obstructing them in the performance of their duties, is liable to a penalty not exceeding $25." As London enforces these ordinances, the work of the street cleaning department is reduced accordingly.

As intended to show the possible influence of the work performed by his department, Mr. Coleman gives the population and death rate, as figured by the Board of Health, for the following years:

YEAR.	POPULATION.	DEATH-RATE PER 1,000.
1881	1,242,533	31.08
1882	1,279,569	29.64
1883	1,317,691	25.81
1884	1,356,968	25.82
1885	1,397,395	25.53
1886	1,439,637	26.96
1887	1,481,920	26.29
1888	1,526,081	26.23
1889	1,571,558	23.00

In figuring out the population the annual increase is assumed at 3 per cent., based upon the State census of 1875 and the United States census of 1880. At the meeting of the Board of Health in October, 1889, the weekly report showed that the death-rate had fallen to 18.80 per 1,000, the lowest rate since 1866. (MULHALL gives the death-rate of New York for 1878-80 as being 26.2 per 1,000.—ED. ENG. NEWS.)

All ashes and garbage collected are sent to sea in scows and deposited in deep water about 3½ miles off the Coney Island shore, and about 6½ miles S. S. E. of Coney Island Point. The cost of final disposition of the refuse of New York on boats per cartload, during the past seven years, has been: 1882, 20.53 cts.; 1883, 19.37 cts.; 1884, 17.77 cts.; 1885, 17.44 cts.; 1886, 17.44 cts.; 1887, 17.16 cts.; 1888, 18.00 cts.

In regard to the cremation of refuse Mr. COLEMAN gives the following figures as gathered in a visit to England; he does not think it has been a success from an economic standpoint. In Bolton, England, with a population of 106,000, there is one refuse destructor in operation. The building and three acres of land cost $110,000; the quantity of refuse burned is about 240 tons per week, or about 12,480 tons per annum, at an average cost of 20 cents per ton. In Leeds, with 323,000 inhabitants, two destructors and one vegetable carbonizer cost (exclusive of site) about $60,000. The quantity cremated weekly is about 490 tons, or 25,000 tons per year, at an average cost of 38 cents per ton. In Bury, population 53,000, one destructor cost about $17,000 and cremates 84 tons per week at an average cost of 42 cents per ton. In Bradford, population 205,000, two destructors cost about $46,000 (exclusive of site), and these cremate about 480 tons of refuse per week. As a ton of English refuse is about equivalent to a New York cartload, the foregoing figures show that our disposal is cheaper than cremation as yet.

Mr. COLEMAN concluded his address by condensing his recommendations for improvements as follows:

Put the pavements in good order; have all breakages of street surface made under the supervision of a department or officer that is held responsible for the cleanliness of the streets. In replacing the pavement, make the joint with asphaltum or cement mortar. Enforce the existing regulations regarding the throwing of refuse on the streets. Ash and garbage receptacles should only be exposed at a regular hour for collection, and at other times kept out of sight. The ash receptacle should be of iron and of a portable size. As soon as our water supply will allow it, flood the gutters of the principal streets every morning as is done in Paris.

The Best Form of Scrap Cabinet.

By T. SPENCER MILLER, M. E.

The accompanying illustration gives an idea of the appearance of a scrap cabinet which has been used long enough to have proven thoroughly satisfactory. This cabinet has 12 *dust-proof* drawers, like that made of cardboard covered with cloth. Provision is made for allowing a card to be slipped in for labeling these drawers.

As to size, that is a matter of taste; 13 ins. × 10 1 in. × 1 in. is a good size. It will hold almost any

Scrap Cabinet. T. S. MILLER, M. E.

catalogue and copies of patents without folding. In these drawers are sheets of white writing paper cut to the size of a patent (11⅛ ins. × 8 ins.), and perforated with four staple or clip holes of ⅛ in. diameter. An equal number of separating strips about 1 in. wide are provided, and similarly perforated.

On thin white sheets the scraps are to be pasted, notes and memorandums written, sketches made, and an *index rerum* may also be kept.

These sheets, when gathered—using a separating strip between each sheet—and secured by staples or clips, become the scrapbook, and sheets may be added to or subtracted from *ad libitum*, and also rearranged as often as desired. The pasting is to be done on rainy or dull days, the clipping to be put in its proper drawer as soon as cut out.

When a drawer becomes full, take out the book, have it trimmed and a cover put on, and label it with its proper subject and "Vol. I.," etc.

Thus we have a "universal" scrapbook, and a "continuous" cabinet, which, like wine, improves with age, provided, of course, additions be made continually. Copies of patents may be perforated and bound in with the scraps.

There are many subjects not treated in any book that are thus collected in book form. My collection of matter on rope transmission alone is worth all the trouble I have been to in devising and maintaining this plan, for this collection dates back more than 20 years, and consists of clippings from papers, blue prints of negatives made from books out of print, written copies of old engineering papers

found in reference libraries, tracings from foreign patents and copies of American patents.

All these collected under one cover forms a collection worth all the trouble and expense of making it.

Prize Papers on Road Making and Maintenance.

The University of Pennsylvania has taken action which we trust will result in good in offering prizes of $400, $200 and $100 (raised, we believe, by a public subscription) for the best three papers on road making and maintenance, the condition of the competition being as follows:

1. The competition shall be open to all, and will be under the auspices of the University, with the advice of the Committee.

2. The subject should include the engineering, economic, and legislative features of construction, reconstruction, and maintenance, and the advantages of thoroughly scientific treatment, but omit history excepting where necessary to illustrate or impress an argument.

3. The papers should be terse, logical, and original [not compilations], written on one side of a sheet only. It is preferred that they should be in type-writing. A paper may be the joint production of two or more persons.

4. The author's name should not appear upon his paper nor be otherwise prematurely disclosed, but his name and address should be inclosed in a sealed envelope attached to his paper in such manner that it may be readily removed without injury. The papers and envelopes will be correspondingly numbered as received, and the envelopes will remain unopened until after awards of prizes or honorable mention are determined upon, when only those will be opened which correspond to the successful numbers; the rest will be destroyed and the identity of the writers remain unknown.

5. All communications should be addressed to Dr. WILLIAM PEPPER, Provost, University of Pennsylvania, Philadelphia, Pa., and be presented on or before April 5, 1890.

6. The papers received will be submitted to a Board of five or seven Adjudicators, to be appointed by Dr. PEPPER with the advice and consent of the Committee which Board shall be the sole judges of all papers, and will not consider any paper that fails to comply with these conditions. They shall report, if possible, within one month from the date of receiving the papers. The vote of a majority of the Board upon the merits of any paper shall be final.

7. When the adjudication shall be made and reported to the Provost, he shall call a meeting of the Committee, at which meeting he shall open the envelopes corresponding with the successful papers and award the prizes in accordance with the adjudication to the authors then disclosed and entitled to receive them.

The papers for which prizes have thus been paid shall become the property of the University for early publication, after which it is proposed by the Committee to invite a second competition for the best drafts of legislative bills designed to carry out the feature developed by the first competition.

In an accompanying circular the Committee state:

In the historical sketch of its road published by the Pennsylvania Railroad, it is stated that at one time the supervisors and track foremen were satisfied with an excellence far below the ideas of perfection entertained by the managers, and to remedy this the latter adopted the plan of having each supervisor prepare on his division one mile of sample track, not limiting him as to cost, but requiring that it be made as perfect as possible. The officers, supervisors, and foreman then passed over these sample miles, carefully examining each, and at the conclusion of this inspection the most experienced supervisors acknowledged that they had never before known what a perfect track was. May not much the same be said of the majority of people in regard to our common roads—that they have little realizing conception of a perfect road and its economic advantages over an indifferent one? Manifestly, such is the case, and the remedy lies in the direction of the education of the people up to a better knowledge of good roads, which will be followed by a greater appreciation of and a determination to have them.

Like all such education, this must begin at the top, and it is therefore encouraging to notice that there has been an awakening upon the subject of better roads and an evident desire for more knowledge as to their scientific and economic construction and maintenance. This has been shown in a marked degree during the past year in the numerous articles that have appeared in pamphlet form and in the journals and periodicals of the day.

The Governor of Pennsylvania in his last annual message called attention to the subject, and the Legislature, in April last, enacted a law which he approved, providing for the appointment of "a commission to revise and consolidate the laws relating to the construction and improvement of the roads and public highways in this Commonwealth and also to consider the advisability and practicability of the State assisting in the construction and improvement of the same."

It is proposed to make these papers the basis of an effort to secure an efficient organization for the creation and maintenance of better highways, not only in our immediate vicinity but also throughout the State, and it is believed that the general benefits to be deprived from so important a work will prove to be a strong incentive to all public-spirited citizens to coöperate in securing so laudable a purpose.

A NOVEL ARCH.—On Dec. 10, 1889, a test of a novel 10 meter arch took place at Matzleinsdarf, Austria. About fifty of the leading engineers of Austria were present. The arch has a rise of only 1 m., a thickness at the crown of only 15 cm. and of only 20 cm. at the springing line. The material of the structure is a beton composed of one part of Podol Portland cement and three parts clean river sand, laid in courses 4 cm. thick and tamped with wooden blocks. At a distance of 2 cm. from the soffit is a wire net of 10 mm. and 7 mm. wire with meshes of 55 cm., the thicker wires running transversely to the axis of the arch. The loading was done by placing iron rails on the structure and by a locomotive and tender. The greatest deflection was 2 mm.

The Southern R. R. of Austria has adopted this system for street crossings. Its inventor is Mr. Monier. The *Wochenschrift* of the Austrian Engineers' Union promises a full description of tests of this intereeting arch in a few weeks.

PERSONAL.

Mr. ROBERT NELSON has been elected City Engineer of Manchester, Va.

Mr. GOTTLIEB MUTZER, C. E., of Newark, N. J., committed suicide last week.

Mr. D. L. GIBBENS, a member of the Board of Electrical Control, New York City, has resigned.

Mr. R. A. GAMBRILL, who died in New York recently, was Secretary of the Peoria, Decatur & Evansville road for ten years.

Mr. C. SALVETER, for 12 years Superintendent and General Manager of the St. Charles Car Works, St. Charles, Mo., has resigned.

Mr. THOS. B. INNESS has dissolved the firm of Thomas B. Inness & Co., for the purpose of connecting himself with the American Car & Equipment Co., of 10 Wall St., New York.

Mr. WINSLOW T. PERKINS, of Dover, N. H., Manager of the Eastern Railroad department in Portsmouth, will sever his connection there to take charge of the Boston & Lowell division.

Mr. MASON D. BENSON, for more than 40 years connected with the Fitchburgh Railroad and for 29 years Treasurer of the company, died at Cambridge, Mass., Jan. 12.

Mr. F.W. ABBOT, Assistant Engineer at the waterworks extension, St. Louis, Mo., has resigned to accept a position as Engineer in charge of tunnel work, with Messrs. Read & Campbell, City of Mexico.

Mr. J. G. RAWN, formerly Division Superintendent of the Chesapeake & Ohio Ry., has accepted the position of General Superintendent of the Baltimore & Ohio Southwestern, headquarters at Cincinnati, O.

Mr. W. B. TROOP, roadmaster of the Chicago division of the Chicago, Burlington & Quincy R. R., has been appointed Chief Engineer of the Hannibal & St. Joseph R. R. He will be succeeded by Mr. FRED J. ALLEN, engineer of the Galesburg division of the Chicago, Burlington & Quincy R. R.

Mr. ETHELBERT L. DUDLEY, General Manager of the St. Paul & Duluth R. R., died recently. He began railway service in the engineer's department of the St. Louis, Iron Mountain & Southern R. R. Subsequently he was Superintendent of the Southern Pacific, and in 1886 was appointed Receiver and General Manager of the Iowa Central, which position he resigned to become General Manager of the St. Paul & Duluth.

Mr. EDWARD LEWIS, Superintendent of Bridges and Buildings on the Allegheny Valley Railroad, died suddenly at Kennerdell, on that line, Jan. 13, 1890, while being conveyed in a special train to his home at South Oil City. He was born at Penn's Manor, Berks Co., Pa., April 11, 1814. He learned his trade as a bridge builder while in the employ of the firm of Piper & Shiffler, who constructed the bridges on the Philadelphia & Erie Ry. For many years he was in the employ of the Keystone Bridge Co., leaving that firm in 1870 to become Superintendent of Bridges and Buildings on the O. C. & A. R. R. R. In 1875 he assumed the same position on the A. V. R. R., which he retained until his death. He had long being recognized as an authority on bridges, and his work bears witness to his thoroughness and integrity.

Mr. MICHAEL J. GRIFFIN, C. E., has been appointed Commissioner of Public Works at Detroit, Mich. The Detroit *Free Press* gives the following record of Mr. GRIFFIN'S career, by which it would seem a fairly wise appointment had been made:

MICHAEL J. GRIFFIN was born in Ireland in 1852, and came to this country four years later with his parents, who located in Cleveland. He was given a common school education in that city, and when quite young joined a surveying party as chain bearer. After 1872 he spent four years locating railroads in Ohio, Pennsylvania and Minnesota. In 1875 he opened an office in Cleveland as civil engineer and surveyor, and was employed by the city of Cleveland in the construction of the big viaduct as Assistant Engineer and Superintendent of masonry. From 1878 to 1882 he was in the employ of the Lake Shore & Michigan Southern Ry. Co. as Assistant Engineer, from Toledo to Buffalo. After that he worked as a contractor for the North River Construction Co. in building the West Shore Ry. from Buffalo to New York. On that contract he built 60,000 yards of masonry from August, 1882, to March, 1883, and laid and ballasted forty miles of track. In 1883, and until 1885, he was engineer and roadmaster on the New York, West Shore & Buffalo. In 1885 Mr. GRIFFIN took the position of Assistant Engineer on the Michigan Central, having charge of the Canada division until 1889. During that time he built 25 miles of railroad for the company in Northern Michigan. Last year he as a contractor completed five miles of heavy road bed for the Windsor extension of the Canadian Pacific in four months.

TRADE PUBLICATIONS.

—*Florida Times-Union.*—Jacksonville, Fla. Trade edition, January, 1889. Size, 15 × 22½ ins.; 56 pp.; 10c.

This is a special edition containing descriptions of the various towns, business and trade interests, land and manufacturing prospects, etc. It contains numerous illustrations and maps.

—*A Brief History of the Development of Machinery for Unloading and Storing Cargoes of Coal and Ore.*—The C. W. Hunt Co., 45 Broadway, New York City.

This little pamphlet gives a most interesting account of the evolution of coal handling machinery, from the days when it was carried in baskets on the heads of the workmen, each man handling 3 to 4 tons per day, to the latest types of automatic steam machinery capable of taking coal out of a vessel, hoisting it 30 to 90 ft., weighing it and running it back 200 or 300 ft. and placing it in elevated bins or pockets, where it can be drawn into carts by merely opening a valve. With this system, operated on a large scale, the amount of coal handled per day per man employed may be over 200 tons, and the total labor cost may fall as low as one and one-tenth cents per ton in regular work.

The pamphlet contains considerable technical matter of interest to every one engaged in handling coal or ores. A large proportion of the illustrations are direct reproductions from photographs. These, unfortunately, have been generally made on too small a scale to show very clearly. The letterpress of the book is so good that it deserves larger illustrations. Had the book been printed with pages double the size and given a cloth cover, it would have been twice as apt to receive the attention which it deserves from engineers.

—*Light Locomotives.*—Illustrated catalogue of H. K. Porter & Co., Pittsburg, Pa., cloth boards, 4½ × 7½ ins.; 147 pp.

This is one of the modern style of catalogues, and contains much useful and interesting information in regard to light locomotives and light railways of all kinds. It contains dimensions and particulars of various light and narrow-gauge engines, from mogul and eight-wheel types down to those for mines, iron works, plantations, logging roads, etc.; and including motors for street railways. There is considerable reading matter relative to grades, curves, track, the use of engines, etc., and several tables of cost of operation, weights and quantities of track material per mile, weights and capacities of cars, etc. About 60 pages are devoted to a tabulated form of working reports of engines of various classes in actual service.

—*The National Filter.*—Illustrated catalogue of the National Water Purifying Co., New York. Size, 8 × 6¼ ins.; 32 pp.

SOCIETY PROCEEDINGS.

Michigan Sanitary Convention.—A convention will be held March 27 and 28 at Lapeer, Mich., under the auspices of the State Board of Health. Among the subjects for consideration are the water supply and the sewerage and drainage of Lapeer. Secretary, S. D. BROWN, Lapeer, Mich.

Indiana Society of Civil Engineers and Surveyors.—The annual meeting was held in January at Indianapolis. The following officers for the current year were elected: President, R. I. MORRISON, Knightstown; Vice-President, L. S. ALTER, Remington; Recording Secretary, J. R. BROWN, Frankfort; Corresponding Secretary, G. M. CHENY, Logansport; Treasurer, H. B. FATOUT, Indianapolis; Executive Committee, H. I. MORRISON, Knightstown; G. M. CHENEY, Logansport; JACOB NORRIS,

Crawfordsville; W. A. OSMER, Logansport, and R. H. WALLS, Greencastle.

Engineers' Club of Kansas City.—At the regular meeting on Jan. 6 the following officers were elected: President, W. H. BREITHAUPT; 1st Vice-President, J. A. L. WADDELL; 2d Vice-President, A. J. MASON; Directors, Wm. B. KNIGHT, W. KIERSTEAD; Secretary, K. ALLEN; Treasurer, F. W. TUTTLE; Librarian, C. E. TAYLOR.

Connecticut Association of Civil Engineers and Surveyors.—At the meeting held at Hartford, Conn., in January, the following officers were elected: President, F. FLOYD WELD, of Waterbury; First Vice-President, WILLIAM B. PALMER, of Bridgeport; Second Vice-President, E. P. AUGUR, of Middletown; Secretary and Treasurer, F. W. WHITLOCK, of Waterbury; Assistant Secretary, W. H. BURNETT, of Norwich; Executive Committee, F. F. WELD, C. H. BUNCE, C. M. JARVIS, C. E. CHANDLER and B. H. HULL; Membership Committee, T. H. MCKINNEY, E. P. AUGUR and W. B. PALMER.

American Society of Civil Engineers.—Mr. COPE WHITEHOUSE will read a paper at the meeting on Feb. 5, on "The Raiyan Canal and Storage Reservoir (Egypt)," illustrated by the stereopticon. At the Buffalo meeting Mr. COPE WHITHOUSE explained how he had been led to believe that the Pharaohs had made a storage reservoir in the Egyptian desert to the southwest of Cairo, and that he hoped to effect its restoration. In his paper before the Society on Feb. 5, he will give the details of this project, which will add over one-half to the existing, cultivated area of Egypt at a cost of about $10,000,000. The total value of this discovery, therefore, largely exceeds $50,000,000. The storage reservoir will cover 166,000 acres and average 200 ft. in depth.

Western Society of Engineers.—Annual meeting, Jan. 8. Gen. CHARLES FITZSIMONS in the chair in the absence of President CORTHELL. The annual report of the secretary places the present membership at 255, including 84 added to the list in the past year. The total receipts from all sources during the year were $2,501.46, which covered expenses. The officers elected for 1890 were: Mr. L. E. COOLEY, President; Mr. ROBERT A. SHAILER, 1st Vice-President; Mr. W. R. NORTHWAY, 2d Vice-President; Mr. JOHN W. WESTON, Secretary, Treasurer and Librarian; Mr. WILLIAMS, Trustee. Mr. E. L. CORTHELL, the retiring president, in his annual address dealt with Chicago as a center of travel and traffic, and gave statistics to prove this. The remainder of his address referred to the great engineering works of the world now under progress, and illustrated these by some stereopticon views. Judge PRENDERGAST addressed the society on the subject of a great waterway connecting Lake Michigan and the Mississippi river.

New England Water-Works Association.—An adjourned meeting will be held at Young's Hotel, Boston Mass., Feb. 12.

Members are invited to visit the Biological Laboratory and High Service Pumping Station of the Boston Water Works at Chestnut Hill during the forenoon. At 11 a. m., the rooms will be opened for the use of the members; 12:30, meeting of the Executive Committee; 1, lunch will be served promptly at this hour. At 2, reading and discussion of paper, "A Study of Algae Growths in Reservoirs and Ponds," by F. F. FORBES, Supt. Water Works, Brookline, Mass.

This will be followed by a series of brief experience papers. As each topic is to be selected by the writer thereof, there will be quite a wide range of subjects presented.

DEXTER BRACKETT, *President*,
221 Federal street, Boston, Mass.
R. C. P. COGGESHALL, *Secretary*.
New Bedford, Mass.

Engineers' Club of St. Louis.—A meeting was held Jan. 22—President NIPHER in the chair. Thirty-three members and eight visitors present.

Prof. W. B. POTTER addressed the club on the subject of "Fuel Gas." He considered the subject under the heads of natural and manufactured gas. The conditions necessary for the development of natural gas were stated, as well as the reasons for believing that the outlook was not favorable for finding gas in this vicinity, giving the results of some efforts in that direction. The amount of natural gas now being consumed is equivalent to about 15,000,000 tons of coal annually. Manufactured gas was considered under four heads: Retort or coal gas, producer gas, water gas and mixed gas. An interesting table was presented of analyses of the various kinds of gases, comparing their characteristic features. The cost of evaporating 1,000 lbs. of water with each kind of gas was given. The professor was of the opinion that fuel gas could not at present be profitably used under steam boilers. The advantages of gas for this purpose, however, were well known, and he had reason to believe that good results might be obtained by constructing producers in direct connection with the boilers, not attempting any general distribution of the gas. The outlook for cheap fuel gas of the mixed type for domestic use was not considered promising, on account of the great capital required for installment of plant to distribute gas of such comparatively low calorific value, and the risk of future legislation against gas containing so large a proportion of carbonic oxide. There seemed to the author of the paper but little doubt, however, that the "retort," or coal gas, as at present manufactured, would be reduced in price and largely used for domestic purposes. The high calorific value of this gas, and the great improvements made recently in the means of applying it in domestic operations, were considered sufficient reasons for considering development in this direction as promising.

Mr. EMERSON MCMILLIN, President of the American Gas Light Association and of the Laclede Gas Light Co. of St. Louis, stated that the fuel gas question was to him a sort of a hobby. He gave a statement of his experience elsewhere. In his opinion, it was by no means certain that natural gas could not be found in this vicinity, although the conditions appeared unfavorable. Natural gas has sometimes been found where all the indications were against it. He expressed his intention of endeavoring to solve the fuel gas question in St. Louis in the near future, by making and distributing it from an existing plant in this city, and if the people supported the enterprise it would be continued and extended. As to the relative cost of manufacture and distribution, Mr. MCMILLIN stated that in an extreme case which had come under his observation the distribution cost four times as much as the original cost of the gas. In well designed and equipped works, these items of expense should be about equal. The European practice was to estimate that one-third of the selling price of gas should pay the interest on the investment, one-third the cost of manufacture, and one-third the cost of distribution. He called particular attention to the fact that mains used for distributing fuel gas could be used for probably 15 hours of the 24, while those used for illuminating gas were used probably 3 hours. The fixed charges, therefore, per 1,000 ft. of gas delivered would be greatly reduced.

In the discussion it was stated that it was difficult with ordinary fuel gases to give them a permanent odor, which would enable small leakages to be promptly detected. It was also shown that the capacity of steam boilers using fuel gas was almost doubled on account of better distribution of the heat. The gas fields at Sparta and Litchfield, Ill., being referred to, Prof. POTTER said that they were merely local and of no great quantity, and gave further reasons for his opinion against the probability of finding natural gas in this vicinity in quantities large enough for industrial purposes.

WM. H. BRYAN, *Secretary*.

Western Railway Club.—(*Concluded from page 83.*)—The paper by Mr. W. G. CREAMER on Car Ventilation was followed by a discussion in which a large number participated. WM. MARTIN, of the Martin Anti-Fire Car Heater Co., exhibited a deflector to be placed in the window, opening either way, for bringing in a current of fresh air. Mr. W. C. PULLMAN showed the Creamer ventilator, with ejectors in the clearstory for removing the vitiated air from the car and injectors on the side of the car drawing in the fresh air and passing it to the heater. To prevent cinders entering, a No. 16 wire screen and a No. 50 wire screen are placed in the air passage. In answer to inquiries, he stated that the device was superior to the jack on top of the car, in that less smoke and cinders are taken in at the sides of the car than at the top.

Mr. SCHROYER spoke of the system of heating by which a jack on top of the car draws in the air, warms it at the stove, and circulates it through the car.

Mr. GRIEVES, of the Baltimore & Ohio, said that the Creamer Eureka Ejector was in use on the Baltimore & Ohio, and gave better satisfaction than opening the windows in the clearstory. The inlet system, taking the air in at the sides, was not used. He had found that the ejector in the clearstory would act invariably to exhaust the air from the car, and would not admit cinders, as the open sash is apt to do.

Mr. JOHNSON thought it an unnecessary complication of a ventilating system to both force air in and force it out. If fresh air were forced in, the air already in the car must pass out; and if the air were forced out, other air must enter at every opening and crevice. Forced ventilation, then, may be either by the vacuum or the plenum system. The latter, however, is invariably to be preferred, since with the vacuum system a draft entered at every crevice and opening, and the sides of the car are very cold in severe weather. The plenum system tends to send the heated air to the sides of the car. On the Chicago, Milwaukee & St Paul Ry., where they have changed from the ordinary stove to steam heating, they have preserved the ventilating feature of the Spear stove in this way: where the pipe came down by the Spear heater, they have put a box coil surrounded by a Russia iron jacket. They have led the Spear heater pipe to the bottom of that jacket, and, of course, when the car is in motion the air is forced down to the bottom of this jacket and up through the steam coils.

As regards the proper amount of air necessary for ventilation, 600 cu. ft. per hour is generally considered the minimum for each person. In well ventilated public buildings 1,000 cu. ft. per hour for each person is provided. Keeping out cinders is only a matter of providing sufficient wire screens.

Mr. BAKER denied that the Spear stove was the perfection of ventilation, and thought that the ventilators should be independent of the heating system.

Mr. RHODES said that all railroad men were agreed as to the necessity of having good ventilation in cars. The question was, in the first place, whether present methods of ventilation were quite as bad as had been claimed, and also whether the methods which had been proposed were really any great improvement over those now in use. He doubted whether Mr. CREAMER's description of the advantages to be gained by perfect ventilation was not overdrawn. Several railways have coaches in use equipped with excellent systems of ventilation, but he had never heard that any passengers were gained by the improvement.

First of all, we should be quite sure that the car really needs it, so that when you put the ventilator there you will be able to notice an entire change in the atmosphere, so that people would rather go in that car and by that road than on a road not having this device. In connection with this, I am reminded of a test that a man wanted to make on the Burlington road recently. He had a water purifier, which was guaranteed to make pure all waters, even the worst waters on our road. We had one water that was bad, and it would have been a grand thing for us if we could have had it purified. It was so bad that we could not use it in our boilers at all. After the man had tried his purifier on this water for a few days, he said he could do nothing with it—it was the worst water he ever saw. He said, "Haven't you some other water that isn't quite so bad as that for me to test?" What we wanted was to have our bad water purified. Water that we could use was not the kind on which to test a purifier. Now, I do not think the methods that have been mentioned at this meeting are such that if we put them on they would produce benefit such as we would appreciate.

Mr. SCHROYER said railway men were interested in car ventilation and had been for years. The Chicago & Northwestern has used for years a stove surrounded by a Russia iron jacket with an apparatus for introducing fresh air similar to that used by the Spear company on the Pennsylvania R. R. In steam heated cars a similar method is pursued; a jack on top of the car forcing in the fresh air, the hot air is delivered at the floor. The great difficulty in ventilation is to please everybody.

Mr. FORSYTHE spoke of riding in a chair car with single sash and the Baker heater, which was very poorly ventilated, but the conductor told him that it was not possible to keep the car comfortably warm if the ventilators were open. He favored double sash, because in a car the air space per passenger is so limited that a great deal of heat is required to warm the large amount of fresh air which is needed for ventilation. The greatest defect with present methods of ventilation is the failure to instruct the trainmen in the proper use of such appliances as are provided. Ask a brakeman to ventilate the car, and he will very likely open all the transoms. In many sleeping cars you may notice a thermometer hung so high that no one can see what it indicates without the aid of a step-ladder; and even if one could see its reading, it would not tell what the temperature was in the lower part of the car. To hang a thermometer in such a position is about as sensible as for a man to try to find the temperature of his sitting room by hanging a thermometer on his back porch.

He proposed the use of a thermometer with its whole range graduated between 40° and 100° so that the graduations could be plainly seen, and hung where its indications could be readily noted by the brakeman.

After an intermission, the discussion was taken up of the best method of washing locomotive boilers where there is not sufficient time to cool the boiler. Remarks were made by Messrs. BARNES, RHODES, HUGHES, MORRIS, PECK, HARRISON and JOHANN. It was generally found that the more fire brick there was in the fire box, the longer it took to cool off the engine and the greater was the difficulty in washing the boiler.

Mr. PECK advised blowing steam offas soon as the engine came in, and then starting a stream of cold water running into the boiler and a stream of hot water running out. Whether a water leg or a brick arch was best in the fire box was the main question over which the discussion was carried on.

Mr. HUGHES described his experience on Indian railways with petroleum fuel in brick-lined fire boxes. It was necessary to let the engines stand a considerable time before they could be washed out.

It was generally agreed that a water leg increased the steaming qualities of the engine; but it was very difficult to keep tight, and scale was apt to accumulate on its interior. Mr. JOHNSON found that cinders from the fire striking the water leg soon cut it out very thin, and in eight or nine months it would give constant trouble by leakage. He used copper for the water leg; and as he did not think it especially beneficial, he did not attempt the use of steel. In washing out, when the engine was wanted immediately, as was generally the case, he attached the cold water supply to the feed pipe, and let cold water run in as fast as the hot run out, and began washing as soon as the engine was cool enough. In that way an engine could be finished in about 2½ hours.

The question of publishing the proceedings of the Club was brought up, and on motion Messrs. FORSYTHE, CROSSMAN, BARNES, PECK and SCHROYER were appointed a committee on the matter.

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AND

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D. McN. STAUFFER A. M. WELLINGTON

EDITORS.

CHAS. W. BAKER E. E. R. TRATMAN M. N. BAKER

ASSOCIATE EDITORS,

GEO. H. FROST . . . . . BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia, Pa.—Next meeting, Feb. 1. Secy, Howard Murphy, 1122 Girard St.

Engineers' Club of Kansas City, Mo.—Next meeting, Feb. 3. Secy., Kenneth Allen, 200 Baird Building.

Civil Engineers' Society, St. Paul, Minn.—Next meeting, Feb 3. Secy., Geo. L. Wilson, City Hall.

Engineers' Club of St. Louis, Mo.—Next meeting, Feb. 4. "Ventilation," J. H. Kenealy. Secy., W. H. Bryan, 46 Laclede Building.

American Society of Civil Engineers, New York.—Next meeting, Feb. 5. "The Raijan Canal and Storage Reservoir, Egypt," Cope Whitehouse. Secy., John Bogart, 127 E. 23d St.

Western Society of Engineers, Chicago, Ill.—Next meeting, Feb. 5. Secy., J. W. Weston, 230 La Salle St.

Civil Engineering Society (Mass. Inst. of Technology), Boston, Mass.—Next meeting, Feb. 6. Secy., Clement March.

Association of Civil Engineers, Dallas, Tex.—Next meeting, Feb. 7. Secy., E. K. Smoot, Elm and Austin Sts.

Civil Engineers' Club, Cleveland, O.—Next meeting, Feb. 11. Secy., C. O. Palmer, 23 Cedar Ave.

New England Railroad Club, Boston, Mass.—Next meeting, Feb. 12. "M. C. B. Association Form of Contract for Chilled Wheels." Rooms in the United States Hotel.

Civil Engineers' Association of Kansas, Wichita, Kan.—Next meeting, Feb. 12. "English Engineering," O. Mulvey; "The Problem of Railway Terminals in Wichita," R. W. Luttrell. Secy., J. C. Herring, Wichita.

Western Railway Club, Chicago, Ill.—Next meeting, Feb. 18. Rooms in the Phœnix Building. Secy., W. D. Crosman.

Engineers' Society of Western Pennsylvania.—Next meeting, Feb. 18. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—Next meeting, Feb 18. Secy., S. E. Tinkham, City Hall.

New York Railway Club.—Next meeting, Feb. 20. Rooms at 113 Liberty St.

IT is greatly to be regretted that one of the three car stove accidents which we have chronicled this week and last could not have been three or four times as serious as it was, and the others omitted altogether. The frightful peril of burning alive in which some hundred or more persons were placed, and through which or in the midst of which 12 lost their lives, and some 50 were more or less seriously injured, would then have impressed itself on the calloused imagination of the public, which now has passed these incidents almost without notice, and so have increased that general demand for a better system from the outside public, which it is to be feared is the most effective stimulus for its speedy attainment. It is natural that it should be so. We do not say it as a reproach, but merely as a fact. The managing officer who has no particular thanks to expect either from his company or the public for taking a successful step, but who has very serious blame to expect if he goes ahead and incurs large expense which does not afterward prove to be just the right thing, is naturally disposed to be extremely cautious, and quite ready to "wait a little longer" and see what his neighbor's experience is before he commits himself very far. It is well that this should be so, but it is also well that there thould be an impelling force of an opposite character to hasten action, and this will always come most effectively from impressive object lessons of the importance of action. Such, unhappily, small accidents are not, however many of them happen, while a single notable accident, which fills columns of the papers for a day or two, will produce a profound impression with less aggregate suffering.

THE immediate cause of the "Monon" disaster, described in another column, and one of the three just spoken of above, was an "unexplained" derailment just before reaching a small trestle, which had one of the narrow, loose-jointed floors, so discreditably common on American railways, over which it is all but an impossibility that a derailed train should run safely. There is a certain proverb which we will not quote about experience keeping a dear school; with an implication following it that no one is so silly as not to learn in that school at least. But in this case the time-honored proverb would seem at fault, for by a singular coincidence the very same engine which was hauling this ill-fated train was hauling another similar one just six years ago lacking four days (Jan. 31, 1884), when a precisely similar accident happened to its train at another trestle, with an identical fatality, 6 persons killed outright. Not only was this so, but this same locomotive was in a less serious wreck some two months ago, in which also a train broke through a trestle floor. The locomotive has probably learned by this time that such trestle floors are not fit ones for any respectable locomotive to be asked to run over; and we earnestly trust that the officials of the line have learned the same lesson; for it is ceasing to be pardonable that such death-traps as are most of our trestle floors should continue to be perpetuated.

AS for the "unexplained" derailment, we have little doubt that in most of these cases, variously described as "jumping the track," "spreading of rails," and what not, the term "unexplained" is correctly used. Bad track, rails or wheels increase the probability of accident, but be track never so perfect, we apprehend that just the right combination of a jolt, low spot in track, lateral lurch, and hard spot in wheel or rail, may make the flange to mount the rail almost anywhere, It is in every way reasonable that this should happen, and highly improbable that an inch and a quarter flange can *always* suffice to hold wheels to the track unless something breaks. There is negative evidence only in favor of this theory,—in the nature of things it must be so,—but that negative evidence is very strong. Whenever derailment occurs from any cause, there are very likely to be effects flowing from it which will be in good faith taken for the cause, like broken rails, wheels or brake gear, bent axles, overturned or "spread" rails, etc., etc. That such *ex post facto* explanations are often of this nature can hardly be questioned. They are almost sure to be advanced if no better explanation offers; and yet how often it happens that there is absolutely nothing discoverable after a derailment which the imagination can seize on as an adequate explanation of it? The conclusion is all but inevitable that true mounting of rail, without overt provoking cause, does not infrequently occur. If so, it emphasizes the importance of correct design of rail and wheel.

IT looks as if something was going to be done to improve the condition of the streets of New York. The police are to have a certain authority over the street cleaning force; an "active, intelligent" policeman is to be detailed to enforce street cleaning ordinances; storekeepers and householders are to be warned against throwing refuse on the street, and arrested for non-attention to a third warning; rag-pickers are to be stopped from overhauling ash cans and dirt carts; the distribution on the streets of handbills is to be stopped, etc. And last, but by no means least, plans are to be devised whereby the various departments shall work in harmony in all matters relating to the condition of the street surface. This is an excellent programme, and every citizen will earnestly hope that nothing may interfere with its realization.

The one thing very needful in this connection is that the many hopelessly confused and conflicting ordinances of the City of New York be harmonized and codified into one comprehensive code. It is not creditable to this city that at the present time there is no municipal code, or book of city ordinances, at all available. The only method of getting at the real legal status of existing ordinances is to study over the files of the *City Record*, for years back, and even then no one but an expert can gain satisfaction from these. It is practically useless to attempt to enforce ordinances which are virtually unknown to the citizens of New York, and the bill of Senator CANTOR, introduced into the Senate last week, and providing for an overhauling and codification of these ordinances, is most seasonable. With ordinances relating to the streets of New York clearly drawn up so that every one can understand them, and widely scattered so that no one can claim exemption through ignorance of the law, it will be the fault of our authorities if they are not enforced.

NEW YORK CITY now has rapid transit schemes galore; and thanks to the Fassett bill now before the Legislature, several large sized projects have suddenly waked up and are pushing to the front. Among these can be mentioned a call for a meeting of Manhattan stockholders to consider the issue of a blanket mortgage on the present system and to sanction sundry extensions; the East River and Long Island project, including a railway connection by tunnel between the Vanderbilt systems and Long Island; the Henning tunnel under the East River, and lastly the People's Rapid Transit Company. This latter is a very comprehensive project to build a four-track masonry and steel viaduct from the Battery to Spuyten Duyvil, and thence by two tracks to Tarrytown. They expect to operate under the general railroad law of 1850; whether this will be sufficient authority or not, will probably be questioned in the interest of rival projects.

But as far as outlined, the People's Company seem to contemplate an elevated structure that is a radical improvement on existing plans here and elsewhere. They propose to buy the property outright and pass through the block, only crossing the streets at right angles to their line and then passing from 60 to 70 ft. or more above the street surface. Under the four tracks contemplated, two for local and two for express traffic

Iron Highway Bridge across the Noce Cha

FIG. 1. ELEVATION OF ARCH TRUSS.

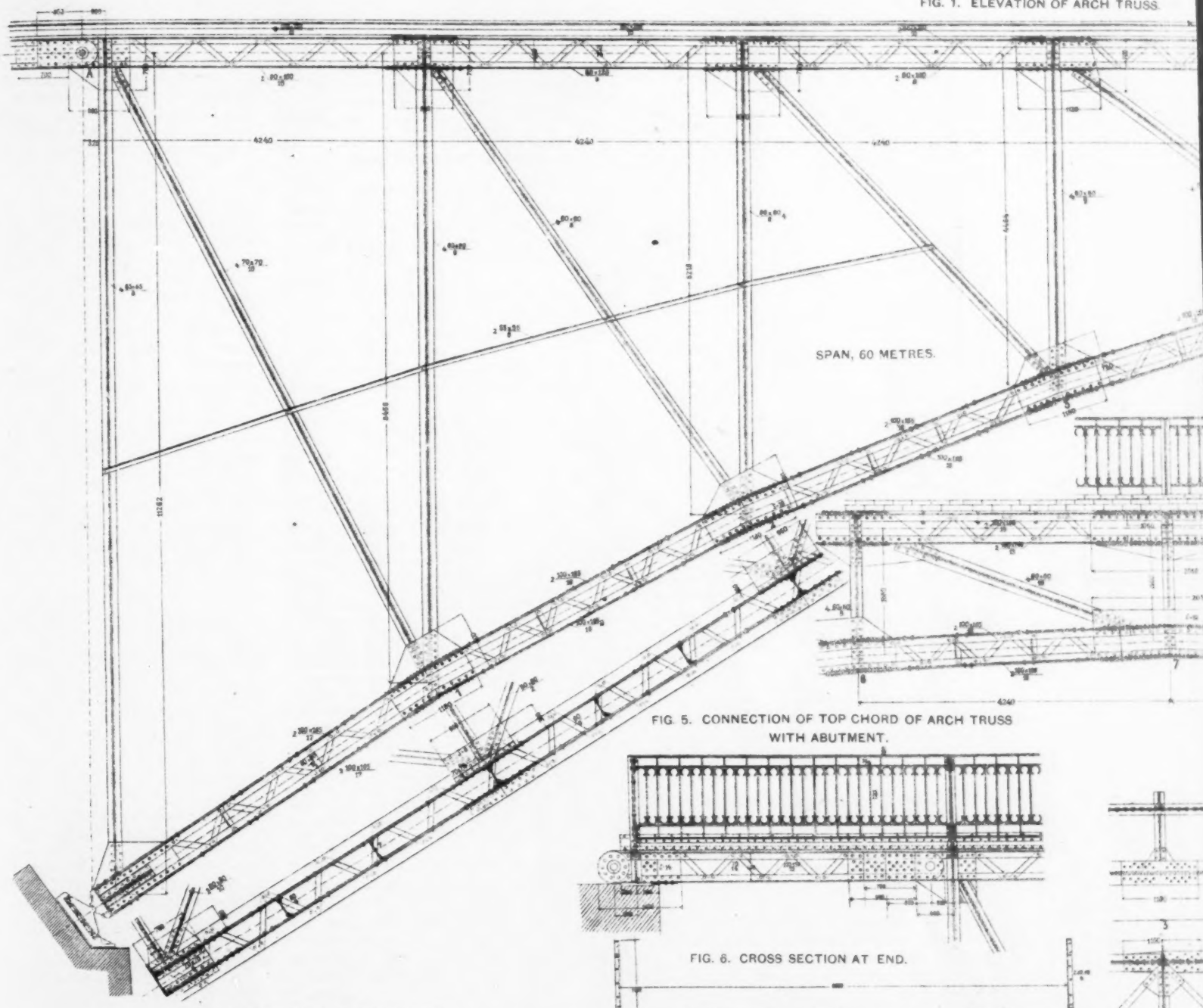


FIG. 5. CONNECTION OF TOP CHORD OF ARCH TRUSS WITH ABUTMENT.

FIG. 6. CROSS SECTION AT END.

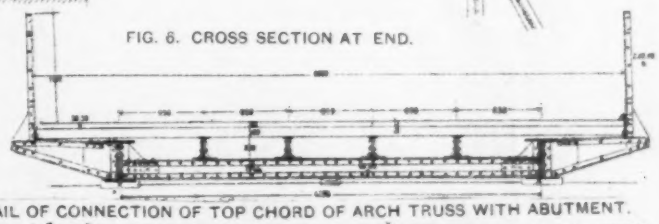


FIG. 7. DETAIL OF CONNECTION OF TOP CHORD OF ARCH TRUSS WITH ABUTMENT.

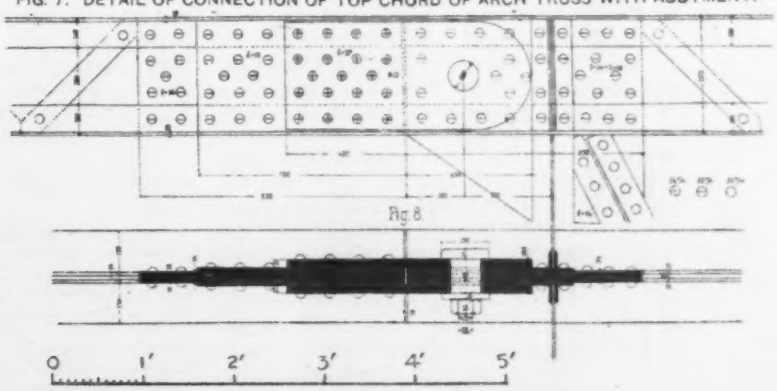


FIG. 9. HINGE AT SPRING OF ARCH.

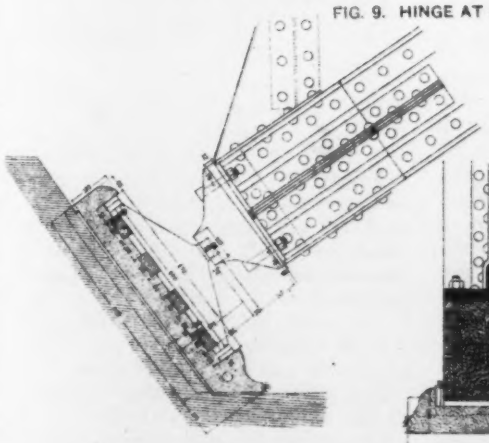
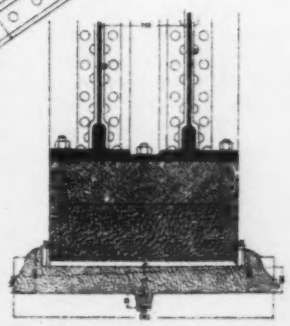


FIG. 10.



OSS THE NOCE CHASM NEAR ST. GIUSTINA.

. ELEVATION OF ARCH TRUSS.

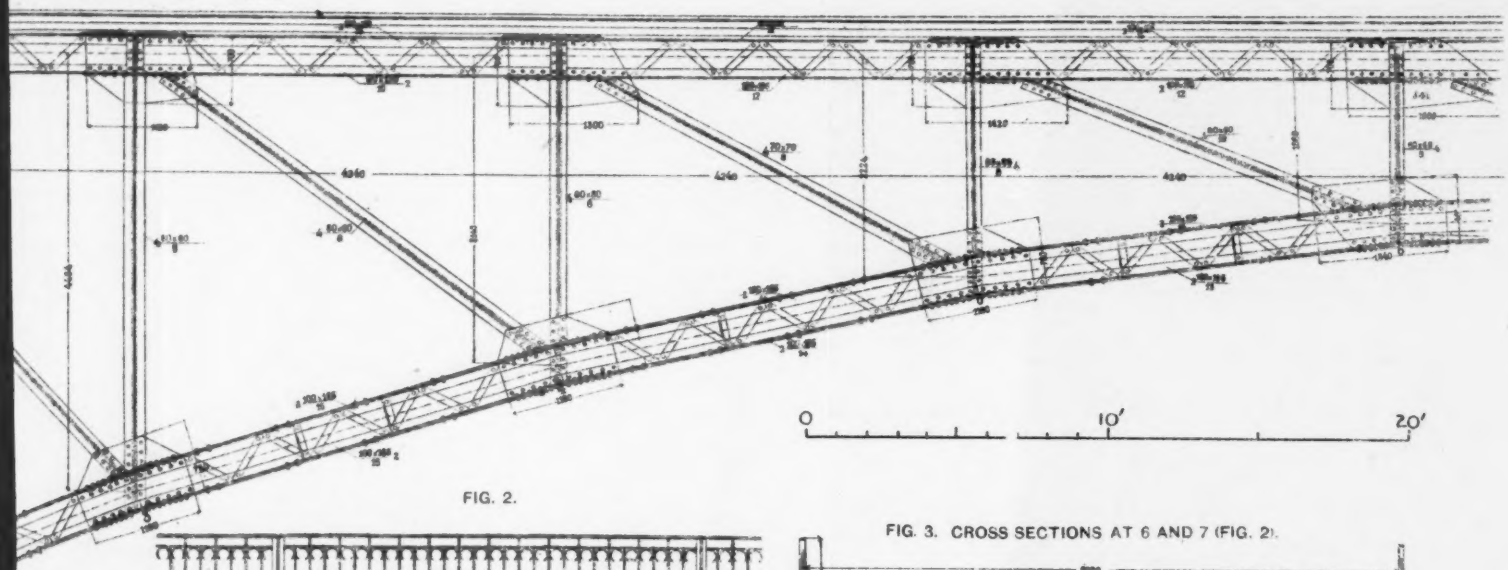
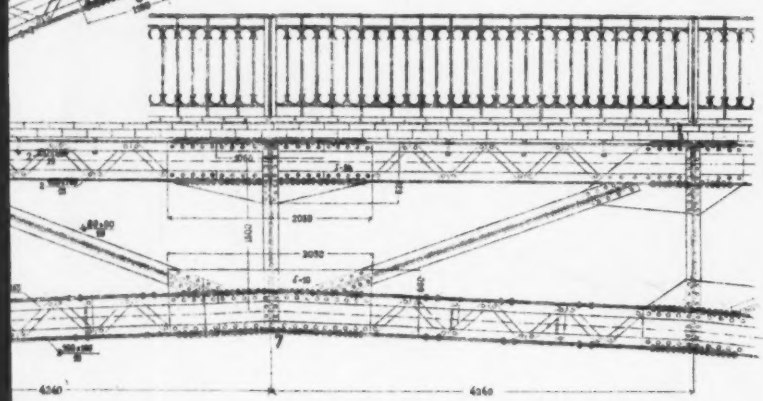
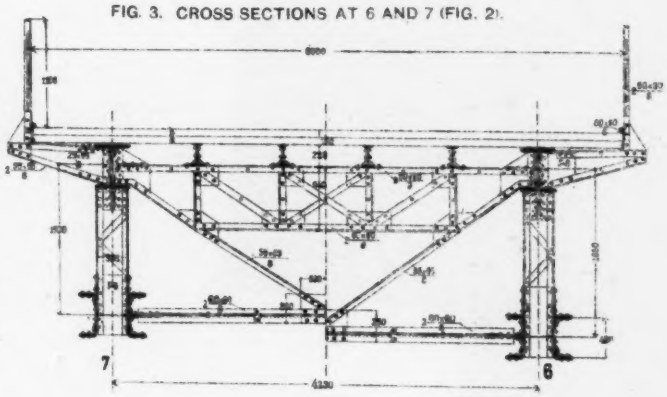


FIG. 2.



RUSS

FIG. 3. CROSS SECTIONS AT 6 AND 7 (FIG. 2).



ABUTMENT.

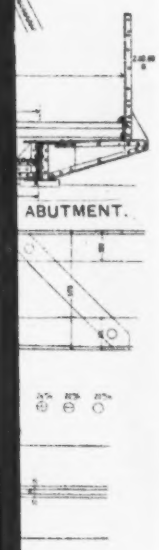


FIG. 4. PLAN OF TOP CHORD.

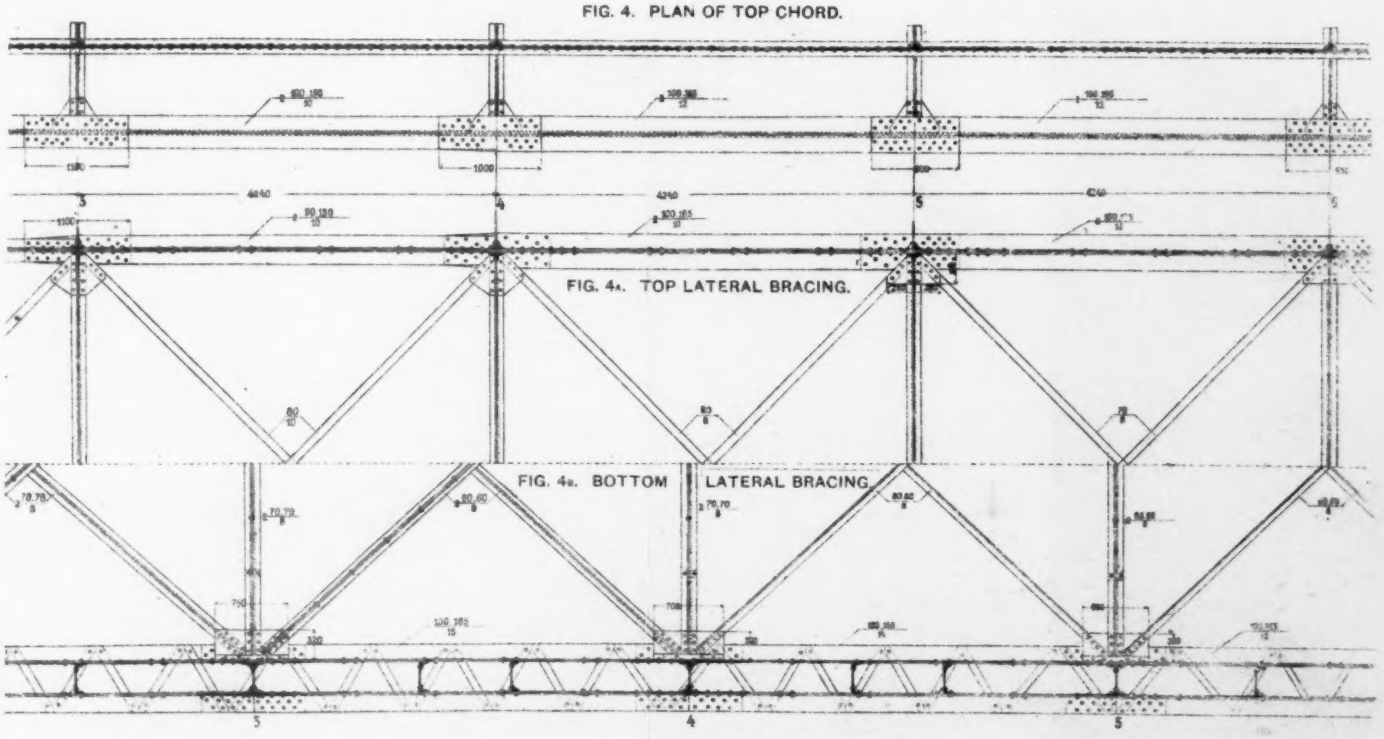


FIG. 4a. TOP LATERAL BRACING.

FIG. 4b. BOTTOM LATERAL BRACING.

ALL DIMENSIONS ARE GIVEN IN MILLIMETRES

CHAS. HART & SONS, LITH. 38 VESEY ST. N.Y.

they propose to erect stores, tenements, etc., so as to obtain some revenue from the real estate investment; the largest item of expenditure, probably, in the rapid transit scheme. Just how much truth there is in the claims of capital secured, right of way obtained, etc., we cannot say; but the scheme of passing through blocks, and thus leaving our streets practically unobstructed, and locating the tracks at such an elevation above the ground as to guarantee a decided decrease in noise and interference with traffic beneath, is a step in the right direction,and it is to be hoped will set the key for any future elevated structures in the city.

If France is to have any reputation left for engineering "level-headedness," it will be well that an extinguisher of some kind should be placed on the various engineers who are now dabbling with the question of starting up anew the Panama Canal project, in various official and unofficial ways. The official "commission" which is now on the isthmus has already shown what seems from this distance an unprofessional readiness to enthuse in public speeches before their inspection was fairly begun, which reminds one most unpleasantly of the palmy days of the Lesseps era. We have not had the patience to read, much less to sift and summarize, all the reported assertions and promises which have been appearing in the press as from this commission, knowing very well that the proper control of the Chagres River alone —a problem not yet touched—would cost enough to make the completion of the canal impracticable now, if it was not in the first place. Doubtless much has been put in the "commission's" mouth which did not actually come from it; for it could hardly be so indiscreet as to assert all that it has been alleged to assert; but of the general fact that it has been indulging somewhat freely in rose-colored generalities about the project does not admit of doubt. To cap the climax of Panama absurdities, however, along come some statements in cold type from one M. G. Sautereau, a former co-laborer with Count De Lesseps on the Suez Canal, who has recently submitted a plan for the construction of the Panama Canal, which, if carried into effect, will, he says, cost the trifle of 400,000,000 francs only, and will enable the through Interoceanic Canal (Panama route) to be promptly opened in "two years, or two years and a half at most." We have space for no more about this project than the estimate, which for sublime independence of other details of construction than the five mentioned is probably without a parallel:

"The cost of the whole work would amount to 400,000,000 fr., and would be expended as follows:

"The Christophe Colomb Lock, 80,000,000 fr.; the Ferdinand de Lesseps Lock, 80,000,000 fr.; expropriations, 20,000,000 fr.; the railroad deviation, 20,000,000 fr., and the Culebra cutting, 200,000,000 fr."

We heartily approve of the movement now on foot in St. Louis to erect a fitting memorial of some kind to James B. Eads. The whole Mississippi Valley, from the Belize to the upper Mississippi and its main tributaries, is interested in honoring the memory of a man who has done more than any other one man for its prosperity and general progress. In building iron-clads to recover control of the great river; in conceiving and pushing to completion the first bridge across the Mississippi proper; and in opening to the commerce of the world the mouth of this river, in the face of ridicule and determined opposition, he has already erected monuments that will for all time enroll his name among those of the great engineers of this century. But it is also very proper in the people most benefited to individually recognize their indebtedness by some fitting memorial erected near the scene of his engineering triumphs, and for this reason the movement noted should be pushed to a speedy and fitting conclusion.

Mr. Washington A. Roebling writes us to say that his name, as one of the incorporators of the proposed bridge across the North River, at New York, was used without his knowledge or consent. We can only say that we used the name as reported in the press accounts from Washington, D. C., but make this correction in accordance with Mr. Roebling's wishes.

Iron Production of 1889.

There is no trustier indication of the general state of business, especially in the engineering industries, than the annual iron and steel output, and for this reason, as well as because of its intrinsic importance, a recent supplement to the *Bulletin* of the American Iron and Steel Association, giving the output each year, has great interest. From this supplement we make a few extracts to show the general tendency, adding some notes from other sources.

The total pig iron products, in gross tons, of the United States and Great Britain, since 1882, stands as follows:

Years.	Great Britain.	United States.
1882	8,586,680	4,623,323
1883	8,529,300	4,595,510
1884	7,811,727	4,097,868
1885	7,415,469	4,044,526
1886	7,009,754	5,683,329
1887	7,559,518	6,417,148
1888	7,998,969	6,489,738
1889 (estimated for Gt. B.)	8,300,000	7,604,525

The *Bulletin* says as to these figures:

When it is remembered that our production in 1888 was the largest in our history down to that time, the magnitude of our production in 1889 will be more fully comprehended. The enormous production of 1889 was better distributed throughout the year than the public has been erroneously led to believe. The production of the first half of 1889 was 3,662,486 gross tons and the second half was 3,942,039 gross tons, an increase in the last half of 279,553 gross tons. The increased production in the second half of 1889 was wholly due to the increased demand for Bessemer pig iron.

In regard to the comparison with Great Britain the *Bulletin* says:

Much has recently been written about the possibility of our overtaking Great Britain in 1890 in the production of pig iron. It has been assumed that we would certainly do this; indeed, that we are now producing at a more rapid rate than the mother country. But we do not think that we will pass Great Britain in 1890 if trade conditions in both countries should continue as they now are.

While this conclusion is no doubt entirely correct as respects the present year, that the time is near at hand when the American output will be and remain far ahead of the British is very evident from the above table, as well as from the general tendency of events. Since 1830 there has been the following great change in the total and relative output:

	Thousands of Tons.				
	1830.	1850.	1870.	1882.	1888.
Great Britain	682	2,250	5,230	8,488	8,300
United States	165	560	1,580	4,023	7,605
Per cent U. S. to Brit.	24.2	24.8	30.2	47.2	91.6

While both countries have made enormous strides, the United States have increased of late years in vastly greater ratio. The United States and Great Britain together produce nearly two-thirds of the total product of the world, a pretty good showing for the English-speaking race, considering that they only constitute $\frac{1}{14}$ to $\frac{1}{15}$ of the world's population:

Of the general state of trade the *Bulletin* remarks:

Never before in all our experience have there been in the same period of time so many changes and so many new enterprises. Notwithstanding the very low prices for many iron and steel products which prevailed during 1888 and the first half of 1889, these two years were the most active in our history in the extension of our facilities for the manufacture of iron and steel in all forms. The great activity in the American iron trade during the last two years has been chiefly noticeable in the erection of blast furnaces in the Southern States and in the erection of steel works in the Northern States.

Nearly all the leading pig-iron producing States shared in the increased production of 1889 over 1888. Pennsylvania shows the largest actual gain, with Alabama next, Pennsylvania's increase over 1888 being 592,056 net tons and Alabama's 341,933 tons. The great progress made by the entire South in the production of pig iron in the last four years is shown in the following table, to which we add percentages:

States.	Net tons.				P. c. inc., 1886–89.
Alabama	283,859	292,762	449,492	791,425	179
Tennessee	199,166	250,344	267,931	294,655	48
Virginia	156,250	175,715	197,306	251,356	61
W. Virginia	98,618	82,311	95,259	117,900	19½
Kentucky	54,844	41,907	36,790	42,518	Dec.
Georgia	46,490	40,947	39,307	27,559	Dec.
Maryland	30,502	37,427	17,606	33,847	10
Texas	3,250	4,383	6,587	4,544	Dec.
N. Carolina	2,200	3,640	2,400	2,898	....
Total	875,179	929,436	1,132,858	1,566,702	79
P. c. U. S. pro.	13.7	12.9	15.6	18.4	....

This shows a truly remarkable increase of product in a region which 20 years ago produced practically nothing.

The production of spiegeleisen has very notably increased from 54,769 tons in 1888, the highest ever known by 6,000 tons, to 86,812 tons in 1889.

The production of Bessemer pig iron was 3,529,584 net tons, with a strong tendency to increase. This naturally argues a heavy increase in the Lake Superior ore output, and the returns of the Marquette *Mining Journal*, just received, show that there has been such an increase indeed. The output of 1889 was no less than 7,292,754 gross tons, an increase of 2,257,343 tons in excess of 1888, or 31 per cent. The estimated output for 1890 is no less than 9,000,000, and the *Mining Journal* says: "Even that enormous quantity may be exceeded if the demand for ore continues as strong as now appears probable. Since 1854, when the output first began, the increase has been as follows:

Lake Superior ore output. Thousands of gross tons.							
1854.	1860.	1870.	1875.	1880.	1885.	1888.	1889.
3	114	831	801	1,909	2,467	5,035	7,293

It is difficult to realize what such a rate of growth as this really means. It means as great an output from this region alone as the entire output of Great Britain about 20 years ago, and as the entire output of this country about 10 years ago.

Signals and Derailing Switches.

The superintendent of a line running many short trip passenger trains, the switching for which at one important terminal is done entirely by hand, recently declared in an official investigation in which he was examined as an expert, that his only anxiety about an immense traffic handled by hand switching, was whether "God had forgotten to put any brains in the switchman's head," so that he should forget to throw the switch right. We will not particularize more fully at this writing, either the road, or the man, or the investigation. The time may come when we shall have to do so. As it happened, within a week after this remark was made in sworn evidence, the superintendent was furnished proof that he was justified in his fears, by one of his men being killed at the very point referred to in his testimony, and in the act of switching.

Apart from this incident, however, it will be plain enough to every one conversant with facts on this subject that the only head into which it could with truth be alleged that "God had forgotten to put brains" was into the head of a man capable of making such a statement as we have quoted; for most men who have cause to study such matters know well by this time that God has put no brains into the head of any human being which will enable him to perform routine duties of any kind without occasional errors—errors which seem so needless and so absurd at times as almost to indicate mental aberration or total depravity, yet which experience makes it certain that some out of a hundred men will at times fall into, and not infre-

quently those who are ordinarily the most careful are the first to do so.

Especially is this true of the observance of signals. If there be anything which is absolutely established by experience, it is that no merely visual signal nor reasonable combination of visual signals will always be seen and observed by those who ought to see them. It has therefore become an accepted axiom among signal engineers that in order to make sure that the signal shall be respected, some other sense than that of sight must be appealed to or some position check introduced, which at crossings and drawbridges is usually a derailing switch, to land the train in the ditch as gently as possible, in case a danger signal is run by.

An incident illustrating this truth very forcibly happened on the Long Island Railroad last week, which furnishes the text for this article (albeit we give our text last) which we cannot describe better than by quotations. In the *Times* the incident was thus described:

The Long Island Ry. narrowly escaped a disastrous accident Tuesday morning, owing to the yet unexplained carelessnss, of the engineer and fireman of the train which left Long Island City for Oyster Bay at 11 o'clock. Yesterday the company secured warrants for the arrest of the accused men, and the company has resolved to prosecute them with the utmost vigor.

The train of which the two men were in charge was made up of two passenger cars well filled with passengers, a baggage car and a locomotive. Something more than a third of a mile from the railway yard the tracks, by means of a low drawbridge, cross the Dutch Kills Creek, which is quite deep and is nearly 30 ft. wide. As the train approached the bridge the tender was just opening it. Signals were shown announcing his intention, but the engineer paid no attention to them and continued to drive his engine with increased speed toward the bridge. The man on the bridge saw that there was no slackening in the speed of the oncoming locomotive, and, summoning assistance, reversed the machinery of the draw, and closed the bridge quicker than it had ever been known to close before.

It was most fortunate that the tender appreciated the situation and acted as promptly as he did, for scarcely had the draw swung entirely into its place and been anchored than the locomotive glided on the bridge rails.

This investigation was very prompt and brief, and as a result of it Superintendent BARTON secured the warrants for the men's arrest. The penalty for imperiling the safety of a railway is very heavy.

There is nothing in this account, which was practically the same in all the New York dailies, to indicate that the drawbridge was properly protected by signals of any kind, and had such been the case, the engine crew might more properly have sworn out warrants against the Superintendent than he against them. Knowing that the Long Island Railroad had taken a quite active part in the introduction of interlocking plant, however, and judging from this that the accounts were defective, we addressed inquiries to Superintendent BARTON, from whom we received the following response:

The Dutch Kills drawbridge is protected by two semaphore signals—a distant and a home signal. The blades of these signals are 6 ft. long, extending over the track. These signals are connected with a lock on the draw. Before the draw can be opened this lock must be removed, and the removal of this lock sets the semaphore signals in their proper position at danger. The distant signal can be seen from a point 3,380 ft. from the draw, and the home signal 2,150 ft. At the late accident both of these signals stood at danger, and, in addition, there was a red flag displayed in the middle of the track, about 100 ft. from the draw, as an extra precautionary measure. There was no lack of, nor any fault in, the construction of the signals which are of the best kind known.

The accident was the result of pure carelessness on the part of the engineer and fireman in not noticing the danger signals. Our rules are very strict in this respect, and the engineer's instructions, both on the time card and in the book of rules, are to approach all drawbridges with train under full control. They must not attempt to cross the bridge until it is known to be all right, and until they receive a signal to that effect from the draw tender.

The engineer's only excuse was that his attention was called to his engine, and that he did not see the distant signal at all, and failed to notice the home signal until too near the bridge to stop. The fireman has the excuse that he was sweeping the tender of his engine at the time and did not see the signals.

There was no lack of precautionary measures on the part of the management, and the accident [can only be attributed to the carelessness of the engineer and fireman as above specified.

This letter shows clearly that there was no lack of the most approved signal appliances to protect the draw except for the one lack of derailing switches. That it was culpable not to have the latter in this case, we are not prepared to say. The draw is very near to the terminal station, over an insignificant stream, and not much used. But all the more it seemed appropriate to use the incident as further illustrating the absolute necessity of using derailing switches if a crossing or drawbridge is to be *fully* protected. Did space permit, we could give dozens of other similar incidents, beginning with the first interlocking signal plant ever erected at a crossing in the United States (if our understanding is correct), at Wellington, O., where both the home and distant signal were run by by one of the most careful enginemen on the road, and collision only saved by the derailing switch, within a few days after the installation of the plant.

The claim of the engineman that he saw the home signal, but did not have room to stop, is obviously most improbable in view of the fact that it was visible 2,150 ft. from the draw. It is not expected that such signals will be looked for only when the train is immediately upon them; and so short a train at slow speed could have been stopped within a few hundred feet, had the signal been really looked for when it should have been.

It is possible that both the engineman and fireman had been drinking, but even if they had, that does not seriously alter the moral to be drawn from this occurrence, which is one that railroad men the world over have been slow to learn—that the brain and senses of a man cannot be made to act with machine-like regularity, but are subject to strange and lawless aberrations in critical moments. Any system which depends for its safety on such machine-like precision in employes is therefore gravely defective, and the real blame for accidents which may result, rests, if anywhere, on those who have demanded more of employes than human nature is equal to, and not on those who temporarily lapse from a prescribed routine

CORRESPONDENCE.

Horatio Allen's Importation of Locomotives—Correction.

SOUTH ORANGE, N. J., Jan. 24, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In ENGINEERING NEWS of Jan. 11 there is a notice of my father, Mr. HORATIO ALLEN. In this it is said, in speaking of the two locomotives ordered by Mr. ALLEN from the Stephenson Works: "And one of them was the engine soon afterward altered by J. B. JERVIS into the first of the now world famed American type, by putting a leading truck under it.

Mr. ALLEN had of late years tried in various directions, but always without success, to trace what became of these two Stephenson locomotives after they were set up in the yard of ABIELA DUNSCOMB, Water St., New York, in 1829, and steam applied to them, the wheels *not* being in contact with the ground. If you can inform me how it was learned that one of them was used by Mr. JERVIS, or give me any information as to where to apply to gain any further information as to what became of either or both of these locomotives, you will greatly oblige me. It was a matter in which Mr. ALLEN felt much interest, and it would have greatly pleased him to trace their further history. L. D. ALLEN.

[We regret that the only light we can shed on this subject is to correct our former statement, which was based upon an impression of many years' standing, but which we now find was incorrect, the locomotive first changed into a truck locomotive by Mr. JERVIS in 1831-2 having been an independent importation of his for the Mohawk & Hudson R. R., as narrated in more detail in our recent article (Jan. 18) on "The Development of the Locomotive." The association of Messrs. ALLEN and JERVIS at that time and the strange fact that these two 1829 Stephenson locomotives are not otherwise accounted for, their subsequent history being lost, doubtless led to our erroneous impression.—ED. ENG. NEWS.]

The Cincinnati, Hamilton & Dayton Disaster.

CINCINNATI, O., Jan. 27, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In your issue of 25th inst. you refer to the late accident on the Cincinnati, Hamilton & Dayton Ry., near Winton place, giving a very accurate account of the affair, with a few exceptions, which I hope you will kindly permit me to correct. The bodies that were taken from the cars were not so badly burned but that a careful examination showed that death had ensued before the flames reached them. The persons killed were all in the back part of the rear car and the flames did not reach them until after the trains had stopped.

Some time ago I was employed to make a survey in a damage case against the C., H. & D. R. R. for the killing of some boys at the Winton Road crossing. In this case the testimony showed that the engine (an ordinary passenger) was "shut off" at about the same place and stopped also at the same place that the "Strong" engine was "shut off" and stopped the night of the accident; thus showing that the latter engine did not by its greater weight and power aggravate the accident or make it any worse than if a lighter engine had been pulling the express; and this fact becomes more evident when we take in consideration the fact that the testimony in the damage case referred to and the testimony in this last accident both show that the engines were running at about the same rate of speed when the danger was first discovered. The facts given you above are from a careful personal examination, as the accident happened within a very short distance of my home.

E. F. LAYMAN.

[We did not, and don't suppose any one else did, attach much importance to the newspaper talk about the "vast weight of the engine" impeding a quick stop; and we earnestly trust that our correspondent is correct in stating that all the deaths occurred before the fire obtained headway. The evidence against the use of cast iron stoves ought to be regarded as just as forcible whether this was so or not.—ED. ENG. NEWS.]

Cross-Breaking Test for Cast Iron.

ST. LOUIS, Jan. 18, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR.—Inclosed I send you a specification for materials which is substantially the same as is used by the St. Louis Water Department for all iron work, machinery, stop-valves, etc. I wish to call your attention to the *cross-breaking test for cast iron*. This requirement was first used in a city contract for water pipe which was signed March 30, 1888. Previous to that the test had been used informally by the department for some months.

Since then this test has been used in preference to others and has given satisfaction; in fact, we very seldom make a test for tensile strength, as it requires turning the bar down in the lathe and gives no indication of the value of the iron for ordinary uses. The deflection of a bar, on the other hand, is a very good index of the metal's ability to stand hard knocks.

A 2,000-lb. testing machine will do the work nicely, and we use a simple adaptation of the micrometer screw to measure the deflection. Bars of the same metal usually agree very well in results, which is one of the best proofs of the accuracy of the method.

I would advise any one intending to use this test to have the bars two inches wide instead of three and to get a 1,000-lb. testing machine arranged for cross-breaking, which can be bought for $100.

In specifying, the load and deflection should of course be taken to suit the work.

For water pipes we take 900 lbs. × 0.30 in. deflection, while for valves, reservoir gates, etc., we take 1,000 lbs. × 0.35 in., and for pumping machinery 1,200 lbs. × 0.40 in.

Very truly,

S. BENT RUSSELL, *M. Am. Soc. C. E.*

The specifications referred to read as follows:

SPECIFICATIONS FOR IRON WORK.

1. All of the iron castings shall be made from a superior quality of iron, tough and of even grain, and shall possess a tensile strength of not less than 18,000 lbs. per sq. in. Test bars of the metal 3 ins. by ½ in. when broken transversely, 18 ins. between supports, and loaded in the center, shall have a breaking load of not less than 1,000 lbs., and shall have a total deflection of not less than thirty-five one-hundredths of an inch before breaking; the bars to be cast as nearly as possible to the above dimensions without finishing, but correction will be made by the Water Commissioner for variations in thickness and width, and the correct result must conform to the above requirements.

2. Specimen bars of the metal of a size and form suitable for testing shall be poured from the ladle either before or after the casting has been poured, as may be required, and shall present a true specimen of the iron used for making the casting.

3. If any two test bars cast the same day show a breaking strength of less than 18,000 lbs. per sq. in., or do not show the required cross breaking load and deflection, all the castings made from the mixture from which the samples were taken will be rejected.

Traverse Surveying.

LOS ANGELES, Cal., Dec. 19, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Since the publication of an abstract of my article on "Traverse Surveying" in your paper, I have received several letters making inquiry for fuller explanation on certain points, and expressed regret that you seemed disposed to discourage further discussion. Permit me a brief explanation in addition to what has already appeared. I wish to say, in the first place, that the editor has fully voiced the writer's private opinion of the relative value of the various so-called systems. Deflecting right and left through 90° is the old method and certainly the best. But when those holding responsible places insist upon the traverse system of surveying, and compel those under them to practice the same, there is certainly some excuse for a short discussion of the subject. Editorial remarks already given show that I am not alone in thinking that Prof. DAVIS' method of using the transit is bad, and that the modified form of traverse surveying suggested "admirable," *when referring all angles to a constant North and South line.* In reply to "G. H. R." I would say, that a more careful study of my field-notes accompanying the sketch would show that the plates are not changed in removing the transit to a new station. For example, the back-sight from sta. C to sta. B, is the same as the previous fore-sight from B to C: Further, "A — B," "B — C," etc., in the fourth column are the measured distances. In reply to "C. C. M." and others, the bearing of side C — D is N 43° 47' W (360° — 316° 13'), and that of "G — A S 70° 30' E (180° — 109° 30').

I am surprised beyond measure to be called upon to answer such questions as the above. And in conclusion I will only add, that having pointed out some of the weaknesses of the traverse system of surveying, and having endeavored to simplify and improve the present practice, I dismiss the subject until defended by its friends.

BURR BASSELL.

A Triple-Headed Rail Section.

GLORIETA, N. M., Jan. 13, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The design for a triple-headed rail, of which the annexed sketch is intended simply to convey the idea [showing three radiating heads at an angle of 120° with each other] has been presented to me, and I wish to inquire if the form is practicable?

Doubtless the same idea has been before evolved, but as I have failed to see any mention or discussion of this design I inquire for my own information.

Of course, as is evident at a glance, the idea is to present a triple-headed rail which shall rest upon two heads while wear is being obtained from the third; the rail to be turned and each head worn in succession. The rail to be properly designed in accordance with scientific principles, as deduced from modern experiments.

Could not such a rail be produced giving three times the wearing service with only from 50 to 60 per cent. more weight than the corresponding sized head of the common rail? It would also make track-spreading impossible.

Would the design be especially difficult to roll? Has this design been presented and discussed in the columns of the ENGINEERING NEWS?

An early reply giving the desired information will confer a great favor.

A. W. HARDY, C. E.

[The idea has been evolved before a number of times. It has no merit, the great difficulty, if there were no other, being that attempts at any kind of reversal of rails have proved a complete failure, the rails being much more likely to break, owing to reversal of former strains. The triple-headed form would aggravate these difficulties. The design would be particularly difficult to roll, in fact, impossible if the heads were really designed "in accordance with scientific principles." It goes without saying from the preceding that the type has not been discussed in ENGINEERING NEWS, and will not be.—ED. ENG. NEWS.]

The Economic Span of Bridges.

KANSAS CITY, Mo., Dec. 17, 1889.

TO THE EDITOR OF ENGINEERING NEWS:

As you have taken up the subject of "Economy in Bridging Rivers," I send for insertion in your paper, if you see fit to publish it, a portion of a letter to *Indian Engineering* relating to the subject, which relates to this question of span-lengths:

". . . The maximum of true economy in a bridge layout is obtained when the cost of the substructure is equal to the cost of the trusses and lateral systems.

This principle I established for myself mathematically some years ago and checked by comparing with a number of complete designs. Although I have stated it in print more than once, I have never hitherto given the mathematical demonstration. . . ."

[Was not this law demonstrated long ago? Our recollection is that we were taught that fact as a student a quarter of a century ago, but cursory search does not recall where, and the demonstration, in any case, will be of interest.—ED.]

Let us assume a crossing of indefinite length with a uniform depth to bed rock.

Let l_1 be the economic span length (not necessarily known).

A_1 = cost per foot of the trusses and lateral systems for the span l_1.

B_1 = cost of metal per foot for the floor system of span l_1.

and C_1 = cost per foot of the substructure for a layout of spans equal in length to l.

Let l = length of any other span than l_1.

and A, B and C=the corresponding values of cost for span l.

Let D = total cost per foot for span l.

Then $D = A + B + C$.

Now it is found by referring to actual weights of bridges that within working limits the value of A varies almost directly as the length of the span, or

$$A = A_1 \frac{l}{l_1}$$

The weight per foot of floor system is practically independent of the length of the span, and varies very slightly with the panel length (of course within the ordinary limits of American practice). Hence we can say that

$$B = B_1 = \text{constant}.$$

Finally, the cost of the substructure may be said to vary (within practical working limits) inversely as the span length. This, of course, is not quite true; for, if in the case of a long crossing, we take out a pier or two by lengthening the span, we may have to increase slightly the amount of materials in each pier; but the cost of each pier by no means increases directly as the amount of materials, so many elements of the cost of construction being constant for piers of varying sizes, when the other conditions are unchanged. At any rate, we make no great error in establishing the question.

$$C = C_1 \frac{l_1}{l}$$

$$\therefore D = A_1 \frac{l}{l_1} + B_1 + C_1 \frac{l_1}{l}$$

Differentiating and dividing both sides of the equation by the differential of l, D and l being the only variables, gives

$$\frac{d\,D}{d\,l} = \frac{A_1}{l_1} + \frac{C_1\,l_1}{l^2}$$

Now if we make the value of $\frac{d\,D}{d\,l}$ equal to zero, it corresponds to a minimum (in this case, *not* a maximum) value of D.

But the condition of D being a minimum can only be obtained when the span length is G, therefore we have the equation;

$$\frac{A_1}{l_1} - \frac{C_1\,l_1}{l_1^2} = o \text{ or } A_1 = C_1$$

which proves that, for the greatest economy, the cost of the substructure must be equal to the cost of the trusses and lateral systems.

Some captious mathematical critic may assert that this investigation is not exact, and that it is, therefore, useless. I grant that as a rule mathematical investigations concerning economy in bridge design are of no account whatever, for the hypotheses upon which they are based are incorrect; but in this case my hypotheses are fairly accurate; and, as before stated, the results have been checked by comparison with the figures of cost of structures designed according to several layouts.

If in any particular case there be a doubt as to which of two layouts will be the more economical, it is always better to choose the one involving the longer spans, because the cost of the substructure is much more likely to exceed the estimate than the cost of the superstructure."

We can test the preceding theory by the example given in Mr. OTTEWELL's paper, in your issue of Dec. 14. Using his 150 ft. span as a basis, it would appear that he figured the cost of timber flooring in place at $1.50 per lineal foot of span, and iron erected at 5 cts. per lb. The weight of iron per foot of floor system may be taken for "Class T," at 320 lbs. per lin. ft., making the total value of the floor system per lineal foot as follows:

Iron, 320 lbs. at 5 cts.	$16.00
Timber	1.50
	$17.50

600 ft. at $17.50 per ft. $10,500 00

—total value of floor system.

Substracting this from the values of the superstructure given in Mr. OTTEWELL's calculations, there results the following table:

Span. Feet.	Cost of Substructure.	Cost of Trusses and Laterals.
300	$9,000	$57,600
120	18,000	17,350
100	21,000	15,480
150	15,000	21,380

The agreement of this example with my theory is quite striking, for in the case of the 120 ft. spans, which Mr. OTTEWELL shows to be the most economical, the cost of the substructure is very nearly equal to the cost of the trusses and lateral systems.

J. A. L. WADDELL.

Col. Leonard Wright.

BALTIMORE, MD., Jan. 26, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Replying to your request in your issue of Jan. 25 for information concerning Col. LEONARD WRIGHT, I can assure you that there used to be, and I trust now is, such a man in the engineering profession. I knew him well at the time he was engaged as division engineer on the Allegheny Valley R. R. in the year 1867. His headquarters were at Franklin, Venango Co., Pa. I have heard nothing of him since about 1870, but should be glad to know of his whereabouts if he still lives.

FRANKLIN WRIGHT was chief engineer of the A. V. R. R. at the same time, *i. e.*, in 1867. The gentlemen were only distantly related—I believe second cousins.

Yours truly, J. B. B.

[If Col. LEONARD WRIGHT be still living, we shall hope to hear still further of his whereabouts, as he will hear through us of "something to his advantage."—ED. ENG. NEWS.]

Standard 80-Lb. Rail Section, N. Y., L. E. & W. R. R.

The accompanying illustration shows to full size a recently adopted standard 80-lb. rail section of the New York, Lake Erie & Western R. R., which is, so far as we know, the first 80-lb. section distinctly based on the recommendations of the late committee of the American Society of Civil Engineers (ENGINEERING NEWS, June 22, 1889; Trans. Am. Soc. C. E., October, 1889), so far as those recommendations went, which were merely as to the form of the head, as to which that committee unanimously recommended "the following details as standards for practice for rail sections of all weights," all of which will be found embodied in the rail section illustrated:

1. A 12-in. top radius. [This was advised by 45 to 9 of the discussions received.]

2. A broad head relatively to depth. [44 to 4 in favor of it.]

3. A ¼ in. corner radius. [36 to 7 in favor of it.]

4. A $\frac{1}{10}$ in. lower radius. [36 to 7 in favor of it.]

5. Vertical sides. [45 to 9 in favor of it.]

In our issue of March 9, 1889, we published an extensive illustrated summary of the "Varying Ideas about 80-lb. Rail Sections," which may very appropriately be studied in connection with this illustration. We then gave cuts of 19 different rail sections, and this was but a part of what we might have gathered by a little more effort. The absurdity of such multiplication of types for a section which must in the nature of things have one best form is too evident for discussion. It is fortunate that a beginning has already been made toward abolishing this senseless diversity by standardizing something, so far as the recommendations of a committee based upon agreement among some 60 or more leading engineers out of 70 who sent in discussions can do so; and as these recommendations cover the most important and most disputed details of rail sections, those relating to the form of the head, it is not unreasonable to hope that the time may be near at hand when such diversity will be completely abolished.

It will be evident by turning back to our issue of March 9, 1889, that one great cause for the diversity referred to, and in fact the only one for very great diversity in the general appearance of the rail sections, is the difference between two opposite theories of what the design should be based on.

The first of these theories, and the oldest one, is that the head is the part subjected to wear; the more metal in the head, therefore, the longer the wear. The more metal put in the neck and base, beyond that necessary for strength as a beam, the less metal to put in the head, and consequently the shorter-lived and poorer the section.

On this theory a large majority of the older sections have been devised, all having a tadpole-like appearance from their slim base and heavy head, which renders them instantly recognizable as a class, despite their differences of detail.

It soon began to be found, however, that these sections, instead of being long-lived, were very short-lived; and of late years an opposite theory has been coming to the front, and may now be said to be so fully established as to be standard practice, from which there is not likely to be much future deviation until present metallurgical processes have been radically modified.

This theory is, that, in order to have the metal firm and homogeneous, there must not be too great differences of mass in the different parts of the section. Otherwise, the thinner parts of the section cool rapidly in the rolls, and the more massive head hardly any, so that, in order that the thinner parts may not become too cool to roll, the initial temperature of the ingot must be high, and also the process of rolling more rapid than it would otherwise need to be, with the effect of leaving the head a comparatively punky, uncompacted mass of metal. The

head, therefore, must not be very deep, and should be as wide as is reasonably possible.

Being designed in pursuance of this theory, it follows naturally that the section illustrated is conspicuous for width of head, being 2¾ ins. wide, the widest vertical side rail of which we have any record. The *extreme* width of the sections we formerly gave ranged as follows:

	Vertical sides.	Flaring.	Total.
2⅞ in.	1	—	1
2½ "	5	2	7
2⅜ "	—	1	1
2⅝ "	1	1	2
2⅛ "	—	1	1
2⅞ "	—	2	2
2⅛ "	—	4	4
2¾ "	—	2	2
	7	13	20

The flaring sides, of course, detract greatly from the top width and bearing surface, usually ⅛ in. at least. The top bearing surface was also greatly diminished in many of these sections the excessively rounded corners, which ranged as follows in the sections:

Less than ½ in...	⅛ in.	2
	7/16 "	3
	5/16 "	3
	3/16 "	2—11
½ in. or over	½ in.	7
	7/16 "	1
	5/16 "	1— 9

Both of the two sections above listed as 2¾ in *extreme* width of head had flared sides and much rounded corners, so that the present section gives the most of nearly flat top bearing surface (2¼ ins.) of any section known to us. As nearly as we can compare this detail by measurements from our standard drawings, the 20 sections which we are able to give compare as follows in *clear* top bearing surface inside of the corner curves:

2 rail sections	have	1⅝ in.
1	"	"	1 7/16 "
5	"	"	1 5/16 "
3	"	"	1⅛ "
1	"	"	1 1/16 "
3	"	"	1 "
3	"	"	15/16 "
2	"	"	⅞ "
N. Y., L. E. & W. has		2¼ "

This being so, it becomes of interest to consider how much the shaving of metal is which converts this unusually wide section from a flat top into a slightly crowning section. Making the simple calculation of the versed sine of a segment 2¼ ins. long of an arc of 12 ins. radius, we find it to be 0.0505 in., or a shade over 1/20 in. The area added by this crowning is about 0.075 sq. in. only, representing ¾ lbs. per yd. This is for one of the widest heads in existence. For the previous maximum width of 2 ins. the crowning is only 0.0416 in., and the area thus added only 0.0277 sq. in., representing only a little over ¼ lb. per yd. of metal.

It is hard for any one not already committed to a theory to see how this thin film of metal can be supposed to have any seriously injurious effect on the life of the rail, especially as its plain effect is only (1) to insure a central bearing instead of a corner bearing for the load, and (2) to fit the ordinary wheel which has seen a few weeks of service, and has consequently become slightly hollowed, a great deal better than any perfectly flat top could. However, we are not at present discussing theories, but chronicling facts.

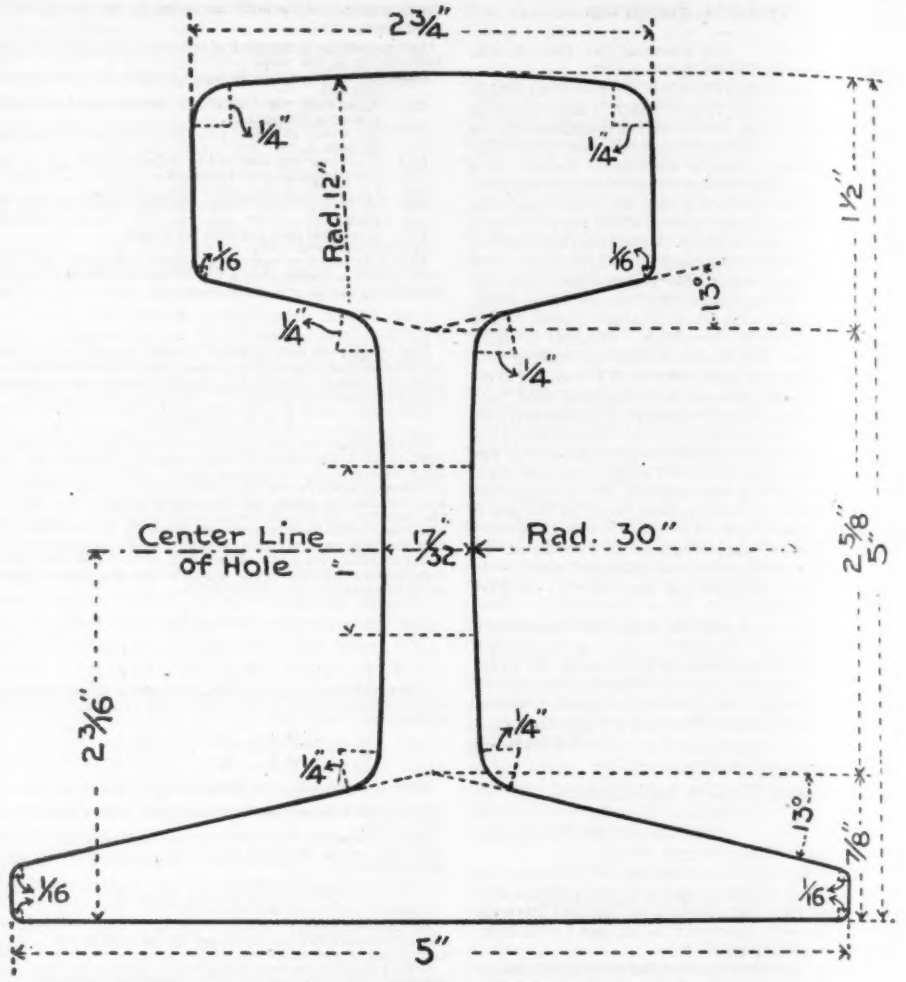
The radius of the lower corner in the sections we formerly gave varied as follows, the N. Y., L. E. & W. section having 1/16 in., as recommended by the rail committee:

1/16 in.	3
⅛ "	5
3/16 "	3
¼ "	4
5/16 "	2
	17

The upper and lower fillet radii vary as follows, there being a remarkable preponderance of practice in favor of a ¼-in. fillet radius, considering that nothing has yet been done to standardize practice in this detail:

N. Y., L. E. & W., AND 10 OTHERS.

Upper fillet.		Lower fillet.	
No.	Radius.	No.	Radius.
11	¼ in.	11	¼ in.
3	5/16 "	—	
—		1	11/16 "
3	⅜ "	3	⅝ "
—		1	9/16 "
1	½ "	2	½ "
1	⅝ "	—	
19 total.		18 total.	



Standard 80-lb. Rail Section, New York, Lake Erie & Western R. R.

[Scale, Full Size less 1/20, due to error of Engraver.]

In depth of head the entire series of sections range as follows:

1 section	[Canadian Southern]	1¼ in.
6 "	[N. Y., L. E. & W. and 5 others]	1⅜ "
1 "		1 9/16 "
1 "		1⅝ "
6 "		1 11/16 "
2 "		1¾ "
3 "		1⅞ "
20 sections.		

With the exception of the Canada Southern, the New York, Lake Erie & Western section illustrated is one of the shallowest, yet no shallower than many others, the most common so-called deep head being only 1/16 in. deeper. Possibly the section illustrated would be better if slightly shallower, and the metal thus gained put in the neck.

For this section lags somewhat behind the general tendency, which we believe to be a good one, in thickness of web, it being only 1/32 in. over ½ in. Our former series of sections ranged in this detail as follows:

7/16 in. neck	2
½ " "	5
9/16 " "	1
⅝ " "	8
11/16 " "	1
¾ " "	3
	20

In extreme height and width this section follows the time-honored rule of base-height, both being 5

ACTUAL RELATIVE AREAS OF HEAD AND NECK AND BASE OF 19 SECTIONS, ILLUSTRATED IN OUR ISSUE OF MARCH 9, 1889, AND OF THE N. Y., L. E. & W. SECTION.

	Rail Section.	Area in sq. inches.				Percentage.			
No.	Maker.	Head.	Neck.	Base.	Total.	Head.	Neck.	Base.	Total.
1	No. Chicago	3.14	1.84	3.05	8.03	**39.1**	**22.9**	**38.0**	100.00
2	"	3.73	1.47	2.60	7.80	47.9	18.8	33.3	100.00
3	"	3.28	1.87	3.02	8.17	**40.1**	**22.9**	**37.0**	100.00
4	Cambria	3.64	1.40	2.68	7.72	47.1	18.1	34.8	100.00
5	"	3.86	1.23	2.36	7.45	51.9	16.5	31.6	100.00
6	Penna. S. Co.	3.84	1.30	2.58	7.72	49.8	16.8	33.4	100.00
7	Union S. Co.	3.17	1.69	3.00	7.86	**40.3**	**21.5**	**38.2**	100.00
8	Scranton S. Co.	3.80	1.42	2.48	7.70	49.3	18.4	32.3	100.00
9	Union S. Co	3.30	1.53	2.74	7.57	**43.6**	**20.2**	**36.2**	100.00
10	Lake I. & S. Co.	3.76	1.37	2.57	7.70	48.8	17.8	33.4	100.00
11	Carnegie	3.86	1.46	2.58	7.90	48.9	18.5	32.6	100.00
12	Canadian So. Ry	3.29	1.72	2.86	7.87	**41.8**	**21.9**	**36.3**	100.00
13	Lack. I. & C. Co.	3.69	1.45	2.70	7.84	47.0	18.5	34.5	100.00
14	N. Y. C. & H. R.	3.44	1.60	2.73	7.77	44.2	20.6	35.2	100.00
15	Penn. R. R.	3.83	1.49	2.99	8.31	46.1	17.9	36.0	100.00
16	"Goliath"	4.88	2.10	3.49	10.47	46.6	20.0	33.4	100.00
17	*Mich. C.*	3.29	1.72	2.86	7.87	**41.8**	**21.8**	**36.4**	100.00
18	London & S. W.	3.89	1.87	2.50	8.26	47.1	22.6	30.3	100.00
19	Cl'd R. M. Co.	4.08	1.34	2.43	7.85	52.0	17.1	30.9	100.00
	N. Y. L. E. & W.	3.59	1.48	2.93	8.00	**44.9**	**18.5**	**36.**	100.00

ins. Our former series ranged as follows, six of the sections being somewhat higher than the width of base, and only one a shade lower:

Extreme height.		Width of base.	
5 in.	10	5 in.	7
4¾ "	2	4⅞ "	1
4½ "	8	4¾ "	9
		4⅝ "	1
	20	4½ "	2
			20

The relative proportions of the base, neck and head can best be shown by the preceding table, in part reproduced from our former article; all the quantites in the table being based upon planimeter measurements in this office of the drawings sent to us, and hence probably not strictly accurate in the actual areas given, owing to differing shrinkage and other irregularities of the drawing. The percentages given in the last part of the table, however, are presumably accurate.

The heavier figures in the last part of this table indicate those designed in accordance with the more modern theory of rail design, and it will be seen that among these sections the neck of the N. Y., L. E. & W. section is one of the thinnest, although many of the older type far outdo it. In area of base also the Erie section is outdone by 3 out of 6 other sections of this type.

It is open to question whether the time has not arrived when all sections of this weight should be designed with a view to the use of some form of metal base plate, and so be made somewhat narrower in base relatively to height.

Judging from the indications which reach us at this office, there is an almost universal feeling that this ought to be done, and willingness to conform all future heavy sections to it. The precise extent to which this feeling prevails, and the extent to which it should be recognized in the design of sections, is one of the most important duties which the newly appointed committee of the American Society of Civil Engineers to recommend standard rail sections will find before it, should the committee itself not be brought to a summary end by the passage by letter ballot of the resolution offered by Mr. DON J. WHITTEMORE at the last annual meeting, that the committee itself be abolished. As the committee was authorized by a vote of 211 to 35, it is hardly to be expected that this will happen; but it will be interesting to find from the second ballot how many members are merely mechanical voters, voting yea or not at all to whatever is offered them. The resolution was offered on the ground that it was not within the proper province of the society to establish standards "for the disposition of material." How much Mr. WHITTEMORE may have been unconsciously prejudiced by the fact that the late committee on the form of rail-heads unanimously reported that they were "entirely clear that the attempt to introduce an entirely flat top is inexpedient," a form of rail which Mr. WHITTEMORE has strongly advocated, we will not attempt to surmise. Certainly no like objection has ever been raised before to the appointment of prior rail committees, and a similar argument would forbid any engineering society attempting to establish standard screw threads.

Locomotive Building in 1889.

A list of locomotives built during 1889 has been compiled by *The Master Mechanic* from special returns furnished by superintendents of motive power and master mechanics. The list shows a total of 826 engines built by locomotive works and 368 built at railway companies shops. It is estimated, however, that the total number built in the United States and Canada, exclusive of those exported, is about 2,100, or six per cent. of the number (36,000) in service at the end of 1888. The list gives the classes and leading dimensions of the engines. Rebuilt engines are not included. From the article in *The Master Mechanic* we take the following notes of the year's work.

We are pleased to note the improvement that has taken place in all directions with regard to the ratio between cylinder power and adhesive weight. Few badly over-cylindered engines have been built during the year. We attribute this desirable state of affairs, in a great measure, to the excellent report presented by the committee on "Proportions of Locomotive Cylinders," at the St. Paul meeting of the Master Mechanics' Association in 1887. The seed sown then is now bearing abundant fruit.

The most noticeable fact which our figures bring out is the growing popularity of the six-coupled engine, chiefly of the ten-wheel type, although the Mogul has many adherents, for fast and heavy passenger traffic. This is the more remarkable as the tendency abroad, more especially in England, is to revert to the two single driving wheels for this kind of service.

The compounding of locomotives has attracted considerable attention during the year. This is due in a great measure to three causes: first the importation by the Pennsylvania Railroad Co. of a Webb three-cylinder compound, built by Beyer, Peacock & Co., of Manchester, England; secondly, the European trip of the American engineers during the past summer, which enabled many of our railway men to investigate personally the details of the various systems, and to satisfy themselves concerning their merits and drawbacks, to an extent impossible by any other means; and, thirdly, the prominence given the subject by the technical press. The two or three papers on compounding read before the railroad clubs have elicited discussion which proves by the intelligence and earnestness displayed, that our more progressive master-mechanics are looking for better things, and are not only willing but anxious to give the compound system a searching trial.

The Pennsylvania Railroad has not as yet made public the results of the tests of the Webb engine, but we believe that the design will not be adhered to in the compound now under consideration at Altoona. The Baltimore & Ohio has already put in service a four-cylinder compound, designed, built, and patented by the Baldwin Locomotive Works. The Michigan Central has bought a compound from the Schenectady Locomotive Works. This engine, which left the shops about the middle of December, is an exact reproduction, with the exception of those changes required for compounding, of the regular type of Michigan Central ten-wheel passenger engine, which the works named have recently been building. The Worsdell-VonBorries system has been used, modified with respect to the starting gear by Mr. A. J. PITKIN, of the Schenectady works, who has been granted letters patent for his improvements. There are no extra handles to be attended to on this locomotive, over and above those used on engines of the ordinary kind, the valve controlling the admission of steam to the 29-in. or low-pressure cylinder being automatic in its operation, and all the engineer has to do in starting is to pull open the throttle, and then to hook the valve gear back as the engine gets into speed in the usual way. This is a very valuable feature, and altogether we consider this engine to contain the elements of success. We understand that Mr. GEO. S. STRONG, of New York, is working on the designs of a four-cylinder compound, which he expects to have ready in the early spring. The Mexican Central are building a compound, and several others are at work upon designs, generally of the two-cylinder type. There are, of course, besides, troops of inventors at work on the subject, who probably see in compounding a new field for the exercise of their talents, now that the car coupler question has been so thoroughly attended to. Whether the application of the principles of compounding to locomotives will be widely made in this country remains to be seen, but we feel confident that there is a great future awaiting it, particularly on the Pacific slope and those other districts remote from the coal fields, where the price of coal reaches an almost fabulous figure.

With regard to external appearance of the locomotives of the year, there has been further improvement in neatness and simplicity. Severely plain dome casings, sand boxes, and smoke stacks, with cabs in keeping therewith have become the rule rather than the exception, and what our English friends have been pleased in the past to call the "gingerbread" finish of our engines has been conspicuous by its absence.

As to the materials of construction, there has been but little change. Steel easily maintains its place as the chief constituent of boilers, but there is a decided objection to its use for stay bolts. We note an increase in the use of Babbitt metal for lining the journal bearings of driving and truck boxes. This is due to the steady increase of the static load per wheel, rising as high as 22,000 lbs. in some cases, rendering some soft metal lining necessary to prevent heating.

The Laird guides are finding favor for all classes of engines on account of their simplicity and efficiency. The four-bar style so long a favorite is not being used so much as formerly, and we are glad to see that on engines where this type of guide is still retained, the old-fashioned cast-iron cross head, with the wrist pin in one piece with the body, is giving place to one having a separate iron or steel pin. The two bar or alligator guide is still much used, and answers well on engines having large drivers, but for Consolidation and other small-wheeled engines, the lower bar is too near the dust and dirt of the roadway for entire satisfaction. The admirable Dean enclosed guide is advancing in favor.

The use of solid-ended bushed side rods is naturally increasing; some roads have gone a step beyond, and make the front end of the main rod in the same way, while the Chicago, Burlington & Quincy has gone further yet in adopting a main rod having both ends solid.

The comparatively large number of Belpaire fire-boxes constructed is noticeable. This system is undoubtedly the most rational method of making a flat-sided stayed fire-box that has yet been tried, and we expect to see an increasing number built year by year. An objection raised to it is the large amount of space it fills up in the cab. This is a serious evil which can be mitigated by striking a large radius at the top sides of the shell. On the Dutch roads, where this fire-box originated, this radius is considerably larger than we make it. The Norfolk & Western on their new 19 x 24 in. cylinder ten-wheelers, besides the Belpaire box, are using what we believe is another invention of Mr. BELPAIRE'S, namely, a large screw in conjunction with the reversing lever for the adjustment of the point of cut-off.

Among the many well-designed engines built during the year, perhaps the most noticeable is the suburban passenger locomotive of the Chicago, Burlington & Quincy. It has six coupled driving wheels, and a pony truck under the coal bunk at the rear end. The design of this engine is characterized by that boldness and freedom from the dictates of tradition that we have become accustomed to look for in the locomotives of this company. We have one serious fault to find with it, however: we consider the interior of the cab too much crowded for convenience of operating, especially that part which falls to the lot of the firemen. The following table gives the leading particulars of this engine, together with those of the engines which may fairly be compared with it. The great adhesive weight of the Q-engine, considered with reference to the mean tractive force, ensures a prompt getting away from stations.

COMPARATIVE TABLE OF LOCOMOTIVES FOR SUBURBAN SERVICE.

Name of Road.	Style of Engine.	Size of Cylinders.	Diameter of Drivers.	Driving Wheel Base.	Total Wheel Base.	Weight on Drivers in working order.	Total Weight in working order.
						lbs.	lbs.
C. B. & Q.	6-coupled tank with rear pony truck	17 x 22 in.	56 in.	14 ft. 4 in.	22 ft. 5 in.	94,000	113,000
London & N. W.	4-coupled compound tank with front and rear pony trucks	14 x 18 in. 26 x 24 in.	56½ in.	7 ft. 9 in.	21 ft. 3 in.	69,664	113,904
"	6-coupled compound tank with front pony truck	14 x 24 in. 30 x 24 in.	62½ in.	14 ft. 0 in.	21 ft. 6 in.	.....	97 440
Illinois Central	4-coupled tank with front pony truck, and rear 4-wheeled truck	16 x 22 in.	56½ in.	7 ft. 0 in.	34 ft. 1½ in.	56,100	empty. 108,700
*Chesapeake & Ohio	4-coupled tank with rear 4-wheeled truck	17 x 24 in.	57 in.	7 ft. 6 in.	23 ft. 7 in.	75,000	110,000
C. & L. M.	6-coupled tank with front pony truck and rear 4-wheeled truck	16 x 24 in.	48 in.	10 ft. 0 in.	30 ft. 0 in.	69,000	112,000

* These engines have had a leading pony truck added recently.

THE LONDON TOWER proposed to outrival the Eiffel Tower is to be 1,200 ft. high. London news items say the company to build it is formed, the stock subscribed and the contracts let. The Hale Elevator Co., of Chicago, is to furnish the elevators, which are practically the same in form as the Otis elevators.

Recent Progress in Sinking Deep Foundations for Engineering Works.*

After a short introduction, the paper refers to the extension of railways and the consequent necessity of bridging large rivers, as the chief cause of progress in deep foundations, and to the improvement in Portland and other cements as the principal factor in rendering such progress possible.

In earlier times timber piling was used exclusively for deep foundations, except in India, where a different method, to be adverted to presently, was pursued. The almost general substitution of iron for timber in engineering works led to the introduction of the screw-pile, first used by MITCHELL in 1834, since largly employed in bridging rivers and in marine piers, there being two forms, namely, two hollow tubes of cast iron and solid forgings of wrought iron. These piles, are, however, unsuitable for very deep foundations where the overlying material is soft or liable to scour, as it is impossible to brace the piles below ground, and the whole structure may therefore become unsteady. Instances of large bridges of this type, with which the author had been connected, are given, in which cylindrical piers had subsequently to be substituted for piles. Many piers have been constructed successfully on marine screw piles, as they are not subject to heavy and fast traffic. One at Huelva, in the south of Spain, is specially mentioned as embodying a novel principal of obtaining increased bearing surface, the area of the screw blades being considered insufficient. Large platforms were sunk round each group of piles, as far as they would go, when temporarily loaded with weights largely exceeding the permanent maximum load on the group. They were then strongly connected with the piling, and the temporary loading removed; the pier, therefore, chiefly rests on these platforms, the extension of the piles below serving to steady the whole.

Cylindrical foundations are next referred to, commencing with the primitive native Indian brick well, only large enough for a man to work inside of, built on wooden curbs, often cemented by mud only, and held together by straw ropes in sinking. Native divers descend in them to a depth of 17 ft. below water, excavating and bringing up basketfuls of sand, and numbers of these wells, sunk close together and filled with concrete, have been used for railway bridge foundations; the concrete in those sunk by the author being made, in those days, of one part lime, two of brickdust, and four of broken stone. Such wells were sunk in India, complete including everything, for about 16 d. per lin. ft.

Larger brick wells and fewer in number are more in use latterly; they are 18 ft. and upwards in diameter, with iron curbs, and have been successfully sunk to over 100 ft. below beds of rivers. A description is given in this paper of a curious operation witnessed by the author at Cawnpore, when the remains of the submerged wells of a bridge, previously carried off by flood, were blown away under the sand by gun-cotton, to make room for the foundations of the present Ganges bridge at that place.

Iron cylinders sunk and filled with concrete are then alluded to, as most generally in use out of India, and having the advantage over brick where deep water has to be dealt with, Mr. Barlow combining both systems in the new Tay Bridge, the foundations of which, and the mode of operations are described in detail.

The stability of cylindrical piers against overturning by flood or drift is adverted to, and instances given of the two cylinders forming a pier being connected together by solid plating in South African bridges to attain this object. Where the sinking is not guided by piles, tapering out at bottom of the cylinders is strongly deprecated, experience amply showing that this renders true vertical sinking very difficult.

Where water-bearing strata have to be passed through, with obstructions which cannot be removed except by actual manual labor, and where the largeness of the area gives room to work in, the pneumatic process has been generally adopted. While applicable to, and often used, in cylinder work, the method is indispensable in inverted caissons. The caisson is like an inverted box, with the open side downwards, and the masonry is begun on the top, which is made specially strong, and is proceeded with as the caisson sinks into the ground, excavated by the men inside of it. Holes or shafts are left in the masonry for the passage of men and material to and from the caisson, and for the supply of the compressed air, which is introduced to force out the water and enable the men to work. Each shaft is provided with an air-lock, a contrivance for preventing escape of compressed air, which is fully described. When the desired depth is reached, the caisson is filled with concrete and left as part of the permanent work.

The pneumatic system has its limit at about 100 ft. below water level, as men cannot work properly under greater pressure than is necessary to sustain a column of water of that height.

In the great Brooklyn Bridge, the caisson is of timber strongly roofed, and in the deeper pier, which is founded 78 ft. below water, it is lined with iron. It was sought in this case to avoid the expense and delay of passing the excavated material through the air-locks, by constructing separate dredging tubes open to the air, which passed through the caisson and below the level of its cutting edge and of the compressed level of water.

The workmen excavated around the foot of these shafts in the caisson, so that the material sunk through the water and under the edge of the dredging tube, inside of which ordinary dredging grabs, working in the usual method, removed it; but it was not a success, as, notwithstanding the care that was taken to keep the foot of the tubes below water, there was a great loss of compressed air.

These caissons are among the largest ever constructed, being 102 x 168 ft. each with 9 ft. 6 ins. depth of chamber. The Brooklyn pier is founded on trap boulders embedded in clay and sand, 45 ft. below high water, and the New York one is sunk through quicksands to rock at a depth of 78 ft. below the same level.

Standing on this enormous structure, which rises 135 ft. above the crowded river, with a span of nearly 1,600 ft., and turning from the magnificent view around, one can hardly realize how the lower parts of the solid masonry of the huge towers could have been actually, so to say, floated and sunk with such steadiness and accuracy as to be effectual for their purpose.

In the Forth Bridge the caissons, which are of iron, are circular, 70 ft. in diameter at the base, four of these forming one of the greatest piers. There is a 7-ft. working chamber at bottom, but the walls are carried up above the roof, and pockets inside the circumference of these upper walls are constructed so as to enable any point to be loaded with concrete, and the sinking to be regulated. Notwithstanding this, one of the caissons tilted over in sinking, and much trouble, delay, and expense were incurred before it was righted. The weight on these foundations, including the tilting action of a wind pressure of 56 lbs. per sq. ft., is about 6 tons per sq. ft.

The foundation of the four legs or pedestals of the great Eiffel Tower in Paris are similar in type, four caissons being used for each foot. The pressure, including the enormous leverage produced by the effect of wind on a structure nearly 1,000 ft. high, is estimated at under 4 tons per sq. ft.

The center pier of the Harlem River Bridge, New York, supporting the thrust of a 510 ft. arch on each side of it, stands on a timber caisson 104 ft. by 54 ft. x 13 ft. deep, divided into three compartments by vertical partitions. These partitions, besides strengthening the caisson, afforded shelter to the men during blasting, as the bottom was rock of greatly inclined surface.

One of the most difficult feats in this kind of work was the sinking of a wooden caisson foundation for a lighthouse in Delaware Bay, an exposed position open to the full fury of the Atlantic. It was towed out with part of the cast-iron shaft upon it, and then further loaded and sunk. The compressed air in this case was also made use of to force the sand up through vertical pipes.

Beyond the pneumatic limit, about 100 ft. under water level, all excavation must be done by dredgers, and special care is required, in the design, that no contingency shall arise at the bottom which has to be dealt with by manual labor, diving operations being impossible. At these depths also, the skin friction, unimportant in a cylinder of moderate depth, becomes so great that special arrangements for overcoming it must be provided.

There are four well-known railway bridges, two now in course of construction, and two completed, in which these difficulties had to be met. The Benares Bridge over the Ganges, the Poughkeepsie Bridge over the Hudson River, the Hawkesbury Bridge in New South Wales, and the Jubilee Bridge over the Hooghly, in Bengal.

In the Benares Bridge the principal piers are sunk to a depth of 140 ft. below water level, and are formed of oval brick wells 60 ft. x 28 ft., and as they had to be begun in water, the bottom lengths are cased in iron. Each is divided into three compartments in which the dredging is carried on.

In the Poughkeepsie and Hawkesbury foundations somewhat identical principles are adopted, namely caissons divided into dredging and loading compartments.

In the American work the caisson is of timber 100 ft. x 60 ft. deep, divided vertically into forty cells, the sinking, which is about 130 ft. x 125 ft. below water, being effected by filling in some of them and excavating in others.

In the Australian bridge the caisson is oval and is of steel and iron 48 ft. x 20 ft., splaying out at bottom 2 ft. more all round, and it has three dredging wells in line at the center, parallel with its length, and splaying out to meet the outer skin and each other at the bottom in a cutting edge. Between the wells and the outer skin, which are strongly stayed together, the space is filled with concrete as the structure sinks. The greatest depth, which is also believed to be the greatest ever reached in a bridge foundation, is 161 ft. below water level.

In the Hooghly Bridge the caisson is somewhat similar in shape to the Hawkesbury one, but has a completely vertical outer skin, and the three dredging spaces extend right across the structure, occupying the semicircular ends and the central portion. Weight is obtained by concreting the two 15 ft. intermediate spaces and by a brick lining around the semicircular ends. In all these cases the wells are of course filled up with concrete when the bottom is reached.

This review as to what has been done is now brought down to the latest date, and a few remarks, founded on practical experience, of several years' standing, of the majority of the systems mentioned, may be made.

No general principle can be laid down as to the preference of any one system over another. As in medicine, so in engineering, and especially as regards foundations, not only does every disease require its own physic, but even the same disease in different individuals demands separate intelligent treatment. Any remarks, therefore, that are made in this paper, must be considered as thoroughly subordinate to this general principle, that every case must be met and dealt with on its own merits.

Having this in view, it must be first remarked that great caution should be exercised in the use of screw piles. In railway structures of any size, they should certainly be avoided, except under special circumstances favorable to their use. Not only does the objection of difficulty of bracing below scourable beds already alluded to, arise, but the whole foundation is dependent on the comparatively perishable material of the screw blade, which in time may corrode unseen, and leave insufficient bearing surface. Subsequent settlement of one pile may distort and strain important parts of the upper structure.

Failures already alluded to, within the author's experience and that of others, have led to these opinions,—failures arising from the system itself, and not from any defects in the special designs adopted in these cases.

With respect to cylindrical or well foundations, it has always seemed to the writer strange that, with few exceptions, notably that of the Tay Bridge, the system of brick wells should be confined to India. There are plenty of rivers bridged elsewhere, in which sandy beds, dry nearly all the year round, point unmistakably to this expedient; in this Cape, for instance where, notwithstanding, iron is preferred. Brick cylinders have the great advantage of supplying their own weight, and of providing a more permanent coating to the concrete core than

*By CHARLES ORMSBY, M. Inst. C. E. Engineer in charge of Hawkesbury Bridge. From "Proceedings of Australasian Association for the Advancement of Science," Sydney.

metal does. Nor will it be found, even when local skilled labor is expensive, that the former costs more than the latter.

The pneumatic processes are largely in favor on the Continent of Europe and in America, and illustrate a successful application of scientific knowledge to practical work. It is a pity that physical conditions limit the extent of the application. The effect of highly compressed air on the human system is that the blood is driven in from the exterior and soft parts of the body to the central organs, especially to the brain and spinal cord, causing violent neuralgic pains and sometimes paralysis.

There is hardly sufficient experience yet of the system of a double casing with the weighting material between, employed at the Poughkeepsie, the Hooghly, and the Hawkesbury, to enable the law to be laid down with regard to them; but the experience so far gained by the author at the latter bridge appears to show that where a great depth has to be reached, there must be ample latitude given in the size of the caisson in plan, so as to allow for any divergence that may occur in sinking. Such divergence, trifling in a shallow foundation, may become serious in a deep one, and the enormous weight of the structure renders control very difficult. Such control may, in the opinion of the author, be given to some extent, in the first place as regards horizontal divergence, by the shape of the lower portion, which should be vertical on the outside. Any outward splay given to this part may intensify a lateral movement, however caused, in the direction of the splay on side by a wedge-like action, while the similar splay on the opposite side has no counteracting influence. In the second place, to counteract any tilting action, the dredging holes should be sufficient in number, and so placed, that by dredging in any one, a "straightening up" effect can be produced, that is to say, there should be four at least, so as to control tilting action towards any of the four cardinal points. It must be remembered that in dredging these deep holes, the slightest tilt throws the dredging grab over to that side of the well, at the bottom, which, in order to recover verticality, ought to be avoided, as it tends to undermine that cutting edge which is already too low. It is different from the case of a foundation of a single large shallow well or cylinder, which can be dredged at any desired point, and that side sunk accordingly.

In the multiple tube system, as it may be called, on the contrary, each well must act for itself in regulating the descent on its own side, and its position should be so fixed in the design as to lead to that result. As these caissons must necessarily be deep in proportion to their area, there is no chance by weighting them unevenly to restore their balance, except when the sinking is just begun.

Metropolitan Sewerage Commission of Massachusetts

The Metropolitan Sewerage Commission has now begun work under the act of the Legislature creating the board, passed June 7, 1889.

A brief history of what has been done previously in the line of this work, before entering upon what the commission proposes to do, would seem properly to come first.

The present scheme known by this name, *Metropolitan Sewerage*, has been in times back called North Metropolitan Sewerage, or Mystic Valley drainage; the primary purpose being to drain the cities and towns comprising the Mystic Valley, which include about one-fifth of the population of the State. These towns and cities are growing fast. Most of the male population do business in Boston, but reside with their families in these suburban places.

In July, 1875, a commission was appointed by the city of Boston to report on a plan for its better sewerage. It consisted of the celebrated engineer, E. S. CHESBROUGH and MOSES LANE, with a physician of reknown, DR. CHAS. F. FULSOM. They reported elaborately on a scheme for the sewerage of old Boston, including the annexes of Roxbury and Dorchester. This was successfully built under the direction of MR. JOSEPH P. DAVIS, at that time city engineer. This district lies all south of the Charles River. The commission paid but little attention to what is called the North Metropolitan district, being that portion of the city which lies north of the Charles River and borders on the Mystic River, comprising the districts of Charlestown and East Boston—the case not being considered urgent with respect to them. The commission did, however, recommend a general scheme, which was to join, these districts with the cities of Cambridge, Somerville, Everett, and Chelsea, collect the sewage into one sewer, take it down by the Winthrop peninsula and empty it at Shirley Gut, a narrow strait dividing the mainland from Deer Island. In this programme it was proposed to have one pumping station on Breeds Island, where the lift was to be from 23 to 30 ft. As before stated, this part of the commissioner's report was not much considered. There were difficulties in the way of carrying it out other than those of engineering, Cambridge, Somerville, Everett, and Chelsea having to agree to the paying of their share of the expense, and no way was advanced for making the apportionment. In this way the matter rested till May, 1881, when a commission was appointed by the governor in conformity with a resolve of the Legislature. It consisted of E. S. CHESBROUGH, C. E., with four associates, and they were directed to report a plan for the drainage of the Mystic Valley, and to include the Charles River Valley, and to recommend a method for the apportionment of its cost. Their recommendations were in general terms, as they did not consider that surveys or close estimates were to be made. Their report was, that for the Mystic Valley the main sewer should take in the several places, follow down the Winthrop peninsula, cross the Shirley Gut, and empty at the lower end of Deer Island. For the Charles River valley they thought the plans on the north bank should join the Mystic system, and those on the south bank the new Boston system emptying at Moon Island. The commission gave considerable attention to the subject of apportionment, as they were directed to by the Legislature. They condemned an assessment based on population, but considered one based on the value of real estate as the most equitable. They recommended that the entire territory draining into Boston should form one metropolitan system, under the charge of a board of commissioners. An act for the consideration of the Legislature also accompanied this report, which the commissioners approved of. Two special points of this proposed act are worth referring to. It directed that the commissioners that were to be created to have charge of the construction and maintenance of the metropolitan sewerage district should be residents of the district and should have the apportionment of the assessments, subject to the approval of the governor and the governor's council.

The act failed to pass, and is only interesting as a matter of history. The subject was again revived in May, 1884, when the Legislature authorized a commission, which the governor appointed, to consider a general system of drainage for the valleys of the Mystic, Blackstone and Charles rivers. There were five members, JOHN Q. ADAMS being chairman. The engineer was ELLIOT C. CLARK, C. E. An elaborate report was made in November, 1885. This was carefully prepared and recommended for what is now called the North Metropolitan. That for the towns and cities of Stoneham, Woburn, Winchester, Medford, Melrose, Malden, Everett, and Chelsea was to be taken to filter beds on the Sawyer Marshes. Charlestown, Somerville and Cambridge were to to be taken under the Charles River near Cottage Farm Station and connected with the Charles River system, which was to connect with the Boston proper improved sewerage system that empties at Moon Island. East Boston, being isolated, was to be allowed to empty into the harbor near Bird Island Shoal. To the subject of apportionment this commission gave much attention. Differing from the former commission, they thought the assessments should be based primarily on population. Mr. CLARKE thought after the works were completed that the cost of maintenance might be allotted according to the amount of sewage received. The arrangements of this report for the disposal of the sewage did not find acceptance by the Legislature or the places to be benefited; so later on the Legislature ordered a new investigation.

In 1887 they directed the State Board of Health to consider and report a plan for the sewerage of the Mystic and Charles River valleys. The board placed the matter in the hands of a sub-committee, of which HIRAM F. MILLS, C. E., of Lawrence, was Chairman, who were to give the subject their special attention. This committee appointed HOWARD A. CARSON, C. E., the engineer to report on a scheme that would take the sewage in a crude state and empty it into the ocean. The committee examined somewhat the methods of disposing of the sewage by filtration, and chemical precipitation, but soon abandoned these processes, considering them not applicable to the case. Mr. CARSON reported in favor of collecting the sewage from the several places forming the North Metropolitan or Mystic Valley district, combining them in one sewer, which should empty at the eastern end of Deer Island from the extremity of a spit or narrow shoal, which runs out from the island 1,900 ft. At this point is found the swiftest ebb tide current in the harbor. It begins to run out an hour before high water, and at certain stages of the tide reaches a velocity of three miles per hour.

MR. CARSON'S plan called for four pumping stations—one in East Medford, one in Somerville, one in East Boston, and one at Deer Island, on the upland, about half a mile from the point of discharge. The lifts at each station being small, about 15 ft., the advantages of which are obvious, this system was to take in the towns and cities of Woburn, Stoneham, Winchester, Arlington, Belmont, Medford, Melrose, Malden, Everett, Chelsea, East Boston, Cambridge, Somerville, Charlestown, and Winthrop—in fact, all the places north of the Charles River except the two small ones of Waltham and Watertown. For the south side of the Charles River, the district containing the city of Venton, Brighton, part of Boston, Brookline, and the towns above named, which were to pass under the Charles River in siphons, was to connect with the Boston main sewer at the corner of Hereford and Camden streets. This disposal of the sewage of places on the southern bank of Charles River was substantially the same as that recommended by the former commission in 1885.

The State Board of Health presented their report in January to the Legislature of 1889. This report did not touch on the subject of the apportionment of cost on the several cities and towns, the main rock, perhaps, on which the former commissions had been wrecked. For, saving the question of cost and how it should be allotted on places benefited, there was nearly a unanimity of sentiment that the sewage of the district should be somehow collected, without causing a nuisance, and emptied out of harm's way into the sea; for the discomforts of bad drainage had been too long experienced to make them unmindful of any relieving process, if to their minds the expense of it was satisfactorily and fairly adjusted. This was the reason why so many commissions had been authorized to provide a remedy for their troubles.

On June 7 an act was passed through its final stages incorporating the "Metropolitan Sewerage Commission," with the usual powers, to construct a system of sewers, following substantially the plans and routes as laid out by the Board of Health in their report. This act, which is believed to be unique in some particulars, is here briefly summarized: While covering but a few pages, it seems to meet the exigency, and was undoubtedly written by some one of legal talent to have been able to solve the problem enough to secure its passage by the Legislature. To build the sewers the act provides that three commissioners shall be appointed by the governor and council, and the State shall issue its bonds to pay for the same. To make the assessments the act provides that the Supreme Court sitting in equity shall appoint three commissioners, who shall determine the part each city and town shall contribute and report the same to the court, and if accepted the award shall be a final adjudication of the matter and binding on all parties. These apportioning commissioners are not to be residents of the district. The proposed act of 1882 provided that they should be residents of the district.

The governor appointed a number of commissioners during the summer of 1889, some of whom were rejected by the council, but in the first of the fall the board were finally completed, the following gentlemen being the members:

HOSEA KINGMAN, TILLY HAYNES, and ROBERT T. DAVIS; EDMUND P. FISK was chosen Clerk, and

HOWARD A. CARSON, C. E., Engineer; JOB P. DAVIS, C. E., Consulting Engineer; Assistant Engineers, CHAS. H. SWAN, WM. M. BROWN, Jr., LAURENCE BRADFORD, J. FRANK WILLIAMS, FRED. V. FULLER, and ALFRED F. BRIDGMAN, Engineer's Clerk. The operations so far have been making surveys for the final location of the sewer line from Deer Island inland and determining the outfall position, and the site of the pumping station at Deer Island. Borings, test pits, and soundings have been made on and about Deer Island for these purposes, to be ready when spring opens to begin the construction of the works.

Hydraulic Ram Experiments.

Some instructive experiments with a hydraulic ram are described in an Austrian exchange. A dwelling house was to be supplied with about 500 litres (132 galls.) per hour from a pond near by. A ram was selected with a 63 mm. (2.48 in.) supply pipe and a 25 mm. (0.98 in.) delivery pipe. The depth of the supply valve below the surface of the pond was 3.25 m. (10.66 ft.), the supply pipe was 14.1 m. (46.2 ft.) long with two very flat curves, the height to which the water was raised was 13 m. (42.65 ft.), the delivery pipe had a length of 84.7 m. (277.9 ft.), the escape valve had an efficient surface of 77 sq. cm. (11.94 sq. in.) and weighed 1.05 kg. (2.32 lbs.).

Under these conditions the ram made 180 strokes per minute, and furnished 283 litres (74.8 galls.) per hour; the waste water amounted to 1,457 litres (384.93 galls.); the efficiency, therefore, was 65 per cent. In order to obtain the required 500 litres (132 galls.) the escape valve stem was loaded until the total weight of the valve was 4.95 kg. (10.9 lbs.) By this means the number of strokes was reduced to 90 a minute; the amount of water raised was 506 litres (132 galls.), the amount wasted, 3,300 litres (871.79 galls.), the efficiency of the ram, 52.63 per cent. If the escape valve was loaded any more, the amount of water furnished was diminished.

After a careful study of these and other results of the same nature, Herr BERNHOFER, the author of the paper, proposes the following formula for the proper weight of the escape valve to obtain the maximum delivery of water.

$$W = \sqrt{\frac{1000 f h l}{h'^2}}, \text{ where}$$

W = weight of valve in kilogrammes,
f = surface of valve in square metres,
h = fall of supply water in metres,
l = length of supply pipe in metres,
h' = maximum length of supply pipe for complete utilization of the energy of the water.

The value of h is probably obtained by EYTELWEIN'S formula (the author does not state this in his paper), which is

$$h = h_1 + 0.3\,\frac{h_1}{h}$$

in which h_1 is the height to which the water is raised above the ram.

The Mississippi River Bridge above New Orleans.

Mr. E. L. CORTHELL, C. E., in an official report just received, gives some further data on the proposed Mississippi bridge designed by him to cross the river about nine or ten miles above New Orleans. As planned this structure would have three discontinuous spans, about 806 ft. long each, the river being practically half a mile wide at this point. The greatest depth of water is 83 ft. at low-water stage; though the deepest pier will be located in somewhat less depth and the other river pier in 40 ft.; the two shore piers are on the water line. It is proposed to sink the two shore piers 100 ft., and the two river piers 150 ft. below low water.

In the two deeper foundations Mr. CORTHELL proposes to combine the pneumatic and dredging methods. Wells will be arranged in the caisson and through the cribwork to be used by the pneumatic process to the depth of 100 ft.; and these wells are then to be opened and the remaining 50 ft. secured by dredging. The reason given for this combination is, that while the pneumatic process is the more expensive, it is more certain in accurately and reliably handling the foundations, and it is hoped that all sunken obstacles will be passed in this first 100 ft. such as drift timbers, wrecks, etc.

While the cantilever type of bridge is being yet studied, MR. CORTHELL thinks it would be perfectly feasible to carry out and place the long spans proposed by means of immense pontoons. False works, of course, are practically impossible. The clear height of the bridge at the center span above extreme high water would be not less than 82 ft. As the *Chicago*, with her topmasts housed, would require only 82 ft., this is deemed sufficient; the shore ends of the shore spans would be 75 ft above high water. The estimated cost of the bridge described is about $3,000,000.

The New Steel Bridge at Manistrol d'Allier.

The *Annales des Ponts et Chausées* gives details of this bridge, which was built to replace an unsafe suspension structure. It has a clear span of 66.44 m., a roadway of 2.4 m., and two footways of 0.8 m. in width. The trusses are quadruple lattice girders with T-shaped chords. The flooring is carried by girders 1.5 m. apart, the intervening spaces being filled with brick arches. The total weight of the bridge is 5,200 kilos., the allowable load is 1,200 kilos. a meter, the allowable tension in the chords, 1,000 kilos.; in the lattice work, 800 kilos.; in the floor girder, 600 kilos. a sq. cm. The steel was tested with the following results: 47.3 kilos. ultimate strength; elastic limit, 31.3 kilos. a sq. mm.; elongation, 23.7 per cent. The cost of the bridge was 80,000 fr., of which 5,000 were expended for removing the old structure and 65,000 fr. for the steel. The entire reconstruction was finished in 90 days. M. EIFFEL was the engineer, MM. REVOL and LORDERAN the resident engineers of the bridge.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Pennsylvania, Lehigh & Eastern.—A press dispatch states that work is well under way on this road, and that the eastern end will be in operation by next summer. The company is a reorganization of the Lehigh & Eastern Railroad Co., chartered about 25 years ago to build a railway from Tomhicken, Pa., to Port Jervis, N. Y., a distance of about 100 miles. S. F. PIERSON, of Philadelphia, Pa., is President.

Mahonjng Coal.—The capital stock of this company has been increased $1,300,000.

Cooperstown & Charlotte Valley.—At a meeting recently held to consider the extension of this road from Davenport Center to Catskill, N. Y., the towns of Harpersfield, Jefferson, Gilbon, Prattsville, Ashfield and Windham voted right of way and $100,000 in aid of the enterprise.

Wilmington & Northern.—This company has made a proposition to the Board of Trade of West Chester, Pa., to build a branch from the main line at Lenape station east to that place on condition that $60,000 be raised in aid of the enterprise. The entire cost of the line will be about $150,000. Three routes have already been surveyed, and on two of them the right of way has been obtained. It is probable that the road will be built.

Pennsylvania.—This company is said to be considering the building of an extension from Tiffin to Fostoria, O., a distance of 12 miles, with the probability of extending the line on through the oil region of Ohio to the lumber district of Michigan. The partly graded roadbed of the old Coldwater R. R. will be used for a portion of the distance.

Lehigh Valley.—It is probable that work will soon begin on the Buffalo & Geneva R. R., to run from Buffalo to Geneva, N. Y. The right of way has been nearly all secured between Cheektowaga and Geneva, and the final surveys are being completed. The contracts have been let for the extension from Cheektowaga to the public road in Lancaster. The light work will all be done by the company itself, but there is one section, where the road will pass under the tracks of the New York, Lake Erie & Western and the Delaware, Lackawanna & Western railways, which will be let to contractors. This piece of work involves the removal of 120,000 cu. yds. of earth and the laying of 3,000 cu. yds. of masonry, on which bridges will be built to carry the Erie and Lackawanna roads. The contract will be let in a few days.

Manhattan.—A meeting of the stockholders of the Manhattan Railway Co., operating lines of elevated railway in New York City, will be held on Feb. 26, for the purpose of sanctioning the creation of a blanket mortgage of $40,000,000 on the present system of roads, and of $600,000 a mile on double track and $300,000 a mile on single track of extension hereafter to be built. An official is quoted as saying:

The object is stated in the notice. It is just for a blanket mortgage of $40,000,000 to pay off the existing incumbrances on the property, and to afford a fund to pay for strengthening the Ninth Ave. line, so that we can run heavier engines and more trains, and to buy and improve some terminal property up at the upper end of the line.

New York & Harlem.—A press dispatch states that this New York road has decided to extend its lower headquarters to Mount Kisco, where all needed facilities will be arranged for. As the road is only double track as far as White Plains, work will be commenced at an early day double-tracking from White Plains to Mount Kisco.

Pennsylvania.—This company has purchased the McKeesport & Bessemer R. R., projected to run from Mckeeport to Bessemer, about 4 miles. It is announced that the line will be constructed at once.

Projects and Surveys.

Trenton & Atlantic.—C. C. VERMEULE, of 71 Broadway, New York City, Chief Engineer, has furnished us the following:

Surveys for this road, which is projected to run from Trenton, N. J., via Allentown and Lakewood to Point Pleasant, N. J., a distance of 42.25 miles, were commenced in September, and the line has been located. The work will be heavy in the vicinity of Trenton but light elsewhere; maximum grade 1 per cent., and maximum curve 5°. There will be one 175-ft. iron pivot bridge. The principal business of the road will be the local freight and passenger traffic and the summer travel to the seashore. The contracts for construction will not be let until certain important changes in the company's plans recently decided upon have been completed. J. H. BREWER, of Trenton, N. J., is President.

Troy & New England.—The engineers have completed the surveys for this New York road between Troy and Wynantskill, and the maps and profiles of the route will be made at once and submitted to the committee. W. P. WARREN, of Troy, N. Y., is President.

Toledo, Kendallville & Rochester.—This company has been incorporated in Indiana to build a line of railway from Kendallville through Kosciusko and Fulton counties to Rochester, Ind. Among the incorporators are: GEO. H. TENEY, A. HAYS and N. PARKER, of Boston, Mass., R. TENEY, of Hanover, N. H., and G. WISWELL, of Cincinnati, O.

Canneltown & Georgetown.—A meeting of the citizens of Crawford Co., Indiana, was recently held to take steps towards the building of a railway from Cannaltown, Ind., east along the bank of the Ohio River to Leavenworth and thence to Georgetown, on the Louisville, Evansville & St. Louis R. R. The route is through a thriving portion of the State.

Unadilla Valley.—Incorporated in New York to build a railway from Bridgewater south via Brookfield to New Berlin, N. Y., a distance of 19½ miles. Among the incorporators are FREDERICK F. CULVER, of New York City, and WILLIAM D. EDWARDS, of Jersey City, N. J.

Youngstown & Buffalo.—This New York company has been reorganized and the following officers elected: President, WM. WILKESON, of Lewistown, N. Y.; Vice-President, A. H. DUTTON, Youngstown, N. Y.; Secretary, J. M. DIPSON, Youngstown, and Treasurer, THOS. BRIGHTON. The company proposes to build a railway from Youngstown to Lewistown, N. Y.

Schenectady & Albany.—Articles of incorporation have been filed authorizing this company to build a railway from Schenectady, N. Y., to Albany, N. Y., a distance of 15 miles. Among the incorporators are HENRY RUSSELL, JAS. H. MANNING, and J. W. VAN VALKENBURG, all of Albany.

Kinzua Creek.—Chartered in Pennsylvania to build a railway from Anderson Switch, on the Western New York & Pennsylvania R. R., to a point on the New York, Lake Erie & Western R. R.

SOUTHERN.—Existing Roads.

Alabama Midland.—H. A. SCHWANECKE, of Montgomery, Ala., Chief Engineer, sends us the following data concerning the Montgomery, Tuscaloosa & Memphis R. R.:

The road is to run from Montgomery, Ala., via Prattville and Maplesville, to Tuscaloosa, Ala., a distance of 106 miles. The entire line has been located and the contract for construction let to Jas. M. Brown & Co., of 115 Broadway, New York City, who are now at work on the road between Montgomery and Maplesville. The route of the road is through a fine timber country; maximum grade 66 ft. per mile and maximum curve 6°. There will be an 800-ft. bridge across the Alabama River and a tunnel 875 ft. long. About six miles of the grading has been completed. It is expected that tracklaying will begin about April 1 and the entire road completed by Jan. 1, 1891. The work is in charge of the Chief Engineer.

Lynchburg & Durham.—This company will receive bids until Feb. 3 for trestling, bridging, and grading on its line.

Atlantic & Danville.—This road was opened for traffic from Portsmouth to Danville, Va., Jan. 23, with a celebration at Danville.

Montgomery Belt.—This belt line transfer railway around the city of Montgomery, Ala., has been completed, and will be opened for traffic as soon as the necessary rolling stock arrives.

Georgia Southern & Florida.—Contracts are reported let for the branch from Tipton to Thomasville, Ga., to Morgan & Reynolds, of Macon, Ga. It is expected that work will commence soon.

Savannah, Americus & Montgomery.—This company has let the contracts for widening the gauge from

Americus to Louvale, Ga. It is expected that this will be completed about May 1, and, as soon as finished, the work will begin on the extension from Louvale to Montgomery, Ala.

East & West R. R. of Alabama.—It is reported that this company is considering building an extension from Cartersville to Canton, Ga., a distance of about 18 miles.

Central R. R. of Georgia.—An official of this road is quoted as giving authority to the statement that the Columbus & Rome R.R. is to be changed to standard gauge and extended from Greenville to Newnan, Ga., a distance of 50 miles.

Augusta & West Florida.—Work has been commenced on this road near Augusta, Ga. The road is projected to run from Augusta to Thomasville, Ga., a distance of 230 miles. The officers of the company are: C. E. SMITH, of Augusta, Ga., President; A. P. WRIGHT, of Thomasville, Ga., Vice-President; COLDEN RHIND, of Augusta, Secretary; W. N. MERCIER, of Augusta, Treasurer, and H. L. STURDEVANT, of Augusta, Chief Engineer.

Missouri, Tennessee & Georgia.—The contract for building the section of this road from Hickman, Ky., to Humboldt, Tenn., has been let to E. P. BUELL & Co., of Tarlton, O., who will sublet contracts about March 1. L. B. WRIGHT, of Humboldt, is President.

Charleston, Cincinnati & Chicago.—L. H. VAUGHAN, of the firm of Vaughan & Co., contractors, is reported as saying that about 3,000 men were at work on this road between Johnson City, Tenn., and Minneapolis, Va. He also states that the road will be completed in August or September next.

St. Augustine & North Beach.—A correspondent writes us that this road, which runs from the union station in St. Augustine to North Beach City, Fla., a distance of 5 miles, will be opened for traffic Feb. 1. The work was very expensive,, being mostly marsh work requiring a large amount of trestling; maximum grade 1 per cent. and maximum curve 10°. The road will do a general passenger and freight traffic. J. N. HAZLEHURST, of St. Augustine, Fla., is Chief Engineer.

Charleston, Sumter & Northern.—This South Carolina company is having surveys made for a branch line from Eutawville, S. C., to Pond Bluff, 6 miles.

Kentucky Midland.—This company will ask the County Court of Bath Co., Ky., to extend the time which they have to earn the subscription of $150,000 voted to the road two years ago. Under the present arrangement the company must complete through that county 35 miles by the first of next January, or forfeit the subscription. The time is so short it can get no construction company to undertake to build the road.

The line is being surveyed from Paris to Sharpsburg, and the road will be finished by Jan. 1 surely, in order to get the $250,000 subscribed by Bourbon Co. They get $150,000 when they run to North Middletown and Flat Rock, and the other $100,000 when they get to the Bath and Clark county lines.

Genesis & Obed River.—President LINA BEECHER, of this road, is reported as saying that the surveys were all made and that construction would commence on the extension from the present terminus south of Genesis, Tenn., to Bon Air Coal Mine, Tenn., as soon as the weather permitted.

Projects and Surveys.

Port Gibson & Alabama.—A correspondent writes us that this company was chartered in Mississippi March 11, 1884, to build a railway from Port Gibson east or southeast to any point on the Alabama State line south of Kemper County, Miss. The incorporators have never completed the organization of the company, nor has there been any surveying or other work done on the line. The incorporators are now in correspondence with foreign capitalists, and it is hoped to commence work in the near future.

Gulf & Chicago.—A press report states that President C. C. MERRICK, of Chicago, Ill., who has been in England for some time trying to secure capital for the construction of this road, has succeeded in obtaining the necessary funds, and immediately upon his return the contracts for a portion of the line will be let. The road is projected to run from Mobile, Ala., to Chicago, Ill.

Louisville Southeastern.—A bill will be introduced into the Kentucky Legislature chartering a railway company by this name. GEO. SWEARINGEN, of Louisville, Ky., is interested.

Covington & Louisville.—This company was incorporated in Kentucky in 1850 to build a railway from Cincinnati, O., to Louisville, Ky. The various counties along the route subscribed liberally in aid of the enterprise. Surveys were made, and a large amount of grading and masonry work was done in 1851-53. In 1854 financial embarrassments caused a stop in the work, and nothing has been done since. There is now talk of reviving the enterprise and building the division between Carrolton and Louisville, Ky., the other portions of the lines having already been occupied by other companies. This would require the building of about 60 miles of new line, and the converting of about 20 miles of narrow gauge track to standard gauge.

Lake City & Tampa.—A railway company with this name has been chartered in Florida.

Albany & Cordele.—Prospects for the early construction of this road from Albany to Cordele, Ga., seem good. Nearly $30,000 has been subscribed toward the capital stock of the construction company.

Seaboard.—This company has completed its organization by the election of the following officers: H. D. HAVEN, President, E. R. UPHAM, Vice-President, and ROBERT MIDDLETON, Secretary and Treasurer.

Midlothian, Manchester & Richmond Railroad & Mining Co.—The Virginia Legislature has passed a bill amending the charter of this road The amendment gives the company five years from April, 1889, in which to build its road.

Memphis, Arkansas & Texas.—This company has been incorporated in Tennessee to build a railway from Memphis southwest to a point in Texas.

NORTHWEST.—Existing Roads.

North & South R. R. Co. of Illinois.—Articles of incorporation have been filed in Illinois empowering this company to construct a line of railway from Eureka, Woodford Co., through the counties of McLean, Tazewell, Logan, Sangamon, Montgomery, and Macoupin, to Alhambra, Madison Co., and to lease any lines already constructed between those points. This is in reality a reorganization of the St. Louis & Chicago Ry. Co., now operating a line of railway from Springfield to Alhambra, Ill. The property is now in the hands of a receiver. The line from Springfield to Eureka, 72 miles, is a proposed extension of the St. L. & C., which has been under consideration for several years, and upon which considerable work has been done in surveys and grading.

Projects and Surveys.

Port Edwards, Centralia & Northern.—Incorporated in Wisconsin to build a line of railway from Port Edwards, Wood County, via South Centralia, Centralia and Vesper to some point on the Wisconsin Central R. R. Among the incorporators are: F. D. WOOD, of Grand Rapids, Wis.; THOS. E. NASH, of Centralia, Wis., and WALTER A. SCOTT, of Merrill, Wis.

Superior Belt Line.—The incorporators of this company, noted in our last issue, are: FRANK A. FLOWER, F. G. WILSON, JNO. MATHER, FRANK A. ROSS and H. G. CAMPBELL, of Superior, Wis., and JAS. B. THAYER, of River Falls, Wis.

Brown's Valley & Bretton.—A company has been organized to build a railway from Brown's Valley to Bretton, So. Dak., a distance of about 55 miles. It is stated that surveys will be commenced at once and the line built this year.

Montana & Canada.—It is announced that arrangements for the construction of this road have been completed, and that work is now in progress getting out the ties for the roadbed. Locating surveys will soon be commenced under the direction of W. D. BARCLAY, and grading will begin as soon as a sufficient distance has been located. The road is projected to run from Fort Benton Mont., to Leithbridge, Alberta, a distance of about 185 miles.

SOUTHWEST.—Existing Roads.

Cache River Valley.—The contract for building this road, which is projected to run from Shotwell's Station, on the Kansas City, Fort Scott & Gulf R. R. along the Cache River, has been let to C. T. COLLINS, of St. Louis, Mo.

ROCKY MT. AND PACIFIC.—Existing Roads.

San Pete Valley.—It is announced that tracklaying will begin in the spring on the line now graded from Chester to Manti, Utah, 15 miles.

Astoria & South Coast.—At a meeting of the directors, recently held, it was decided to push the work on the construction of this road as fast as possible. Contracts were entered into for building the road from the point to which construction is now completed on the Lewis and Clark River to Hillsboro, Ore. There will be a tunnel 1,500 ft. long on the line.

Projects and Surveys.

Denver, Colorado Canon & Pacific.—Press dispatches state that the engineers now making the survey for this road through the cañons of the Colorado River are working at a point about 100 miles east of Pearl Springs, Ariz.

Pajaro Valley.—This company has been organized to build the railway before mentioned between Watsonville and Salinces, Cal. The road will be about 20 miles long.

Siuslaw & Eastern Railway & Navigation Co.—We are in receipt of the engineer's report, from which we take the following data concerning this enterprise:

The preliminary survey has been completed from Eugene, Ore., to the head of tide on the Siuslaw River, a distance of 47 miles. The surveys show that the line will be easy to construct. The cost of construction from Eugene to Elk Prairie, 22¼ miles, will be about from $8,000 to $10,000 per mile, and from Elk Prairie to the head of tide, 24¼ miles, about $35,000 per mile, this portion of the line being through a mountainous country. The route is through a good agricultural and stock-raising country, rich in timber and minerals. From the head of tide it is purposed to continue the road to Florence or Glenada, a distance of about 18 miles. About 10 miles of this distance will be very hard construction. ALF. KIRKLAND was the engineer in charge of the surveys. The officers of the road are: A. G. HOVAY, President; J. A. STRAIGHT, First Vice-President; W. A. COX, Second Vice-President; J. M. HODSON, Secretary; and E. C. SMITH, Treasurer.

Corvallis, Brownsville & Eastern.—This company has been chartered in Oregon to build a line of railway from Corvallis to Brownsville, Ore. The incorporators: PETER HUME and GEO. DYSONI, of Brownsville; T. J. BLACK, of Halsey, and J. K. BRYSON, of Corvallis.

Cortland, Lower Columbia & Eastern.—The citizens of North Yakima, Wash., have raised $100,000 in aid of this enterprise. The road is projected to run from a point near Vancouver, Wash., through the Lubens Pass to North Yakima.

Roseburg & Coos Bay.—The citizens of Roseburg, Ore., are agitating this project to build a railway from that place west into Coos Co. It is thought that the prospects are good for the early commencement of construction.

Denver Resort.—The surveys have been completed for this 16-mile Colorado railway. J. S. STEWART, of Denver, is Chief Engineer.

Medford & Jacksonville.—Chartered in Oregon to build a line of railway from Medford to Jacksonville, Ore. Among the incorporators are A. H. HULL and JOHN D. WHITMAN. The offices will be at Bidford.

Idaho North & South.—This company proposes to build a railway running from Nampa, Idaho, northwest to a point on Puget Sound. The officers are: President, G. F. CURTIS; Vice-President, J. R. DE LAMAR of Lamar, Idaho; Secretary, JAS. A. MCGEE, Nampa, Idaho, and Treasurer, W. H. RIDENBURGH, of Boise City, Idaho.

FOREIGN.

Western.—Mr. GONZALO ESTEVA, the Concessionaire has nearly completed the financial arrangements, and it is stated that this Mexican road will be built. The road is projected to run from Aguascalientes to Chamela. The States of Jalisco and Aguascalientes have granted subsidies of $2,000 and $3,000 per kilometre, respectively.

Mexican Southern.—Grading has been completed on this road from Pueblo to Tehuacan, 125 kilos.

Michoacan & Pacific.—This road will soon be open for traffic from Maravatio to Angangneo, Las Trojes and intermediate stations.

RAPID TRANSIT.

Electric Railways.—***Rochester, N. Y.***—The Rochester City & Brighton Ry. Co. has applied for permission to operate its lines by electricity. A committee of the Council has been appointed to confer with the company.

Syracuse, N. Y.—Mr. W. J. HART, Superintendent of the Syracuse & Geddes line has been directed to investigate different systems of electric traction. The Sprague, Short and Thomson-Houston systems are under consideration.

Beaver Falls, Pa.—The Beaver Falls, College Hill & Matamora Electric St. Ry. Co. has had surveys made and will let the contract for construction very soon.

Washington, D. C.—The Washington & Highlands St. Ry. Co. has been incorporated and has applied to the District Commissioners for permission to build its line.—The Eckington & Soldiers' Home Ry. Co. has introduced a bill for a new line on North Capitol St.

Newport, Ky.—The Newport Electric Ry. Co., has been incorporated by H. M. HEALEY, H. BUCHANAN, and A. J. PARLIN. Capital stock, $100,000.

Beatrice, Neb.—The Wittenbury Electric St. Ry. Co., has been incorporated by L. F. M. EASTERDAY and others.

Helena, Mont.—The motor line will probably be converted to the Thomson-Houston electric system. Col. JAMES SULLIVAN is the manager.

Dummy Lines.—***Greenville, S. C.***—Two routes have been surveyed for the line to the Paris Mountain Hotel, by Capt. WM. POWELL, the engineer. The estimates are as follows: Grading and filling, $15,000; 30-lb. steel rails, $18,000; cross-ties, $5,500; incidentals, $500; total, $39,000.

Tampa, Fla.—A dummy line is projected to connect Tampa with Ybor City.

Salem, Ore.—The Marion County Improvement Co. is preparing to build a dummy line from Salem to Silverton. Proposals have been advertised for 40,000 ties, to be delivered April 15.

Cable Railway.—***Baltimore, Md.***—The Baltimore Traction Co. is preparing to put in the cable system on the Citizens' and People's lines. P. A. B. WIDENER, WM. L. ELKINS, Sr., and E. J. MATTHEWS, of Philadelphia, are interested. It is hoped to have the line to Druid Park and Patterson Park completed by July 4.

Street Railways.—The Harlem, Mott Haven & Morris Ave. Ry. Co., capital stock $1,000,000, and the Harlem, Brook Ave. & Woodstock Ry. Co., capital stock $1,000,000, have been incorporated by FRANKLIN EDSON, H. N. CAMP, RICHARD KELLY and H. W. T. WALL. The East River, Central Park & North River Ry. Co. has applied for power to build a line through Central Park at 86th St. A. S. BALDWIN is President.

Beaver, Pa.—The Union St. Ry. Co. will build a line from Beaver to Freedom.

St. Augustine, Fla.—A company has applied for right of way for a street railway. Another company proposes

to build a line through New Augustine. For particulars address Dr. RAINEY.

Marion, O.—Arrangements have been completed for the construction of a street railway.

Manistee, Mich.—A franchise for a street railway has been granted to Haines Bros., of Kinderhook, N. Y.

Rockford, Ill.—The Rockford City Ry. Co. has been incorporated by E. W. BRICE, ANTHONY HAINES and LEVI RHODES. Capital stock, $50,000.

Peoria, Ill.—A franchise has been granted to the Riverside Ry. Co. for a line on the Peoria and Galena road.

Duluth, Minn.—The Duluth St. Ry. Co. will build an incline railway.

Madison, Dak.—The Madison St. Ry. & Rapid Transit Co. has been incorporated, and will build its line this spring. Capital stock, $50,000.

Fort Worth, Tex.—The Fort Worth & Arlington St. Ry. Co. has been incorporated. Capital stock, $300,000.—The Chamberlain Investment Co. has let the contract for its street railway to P. P. Ford.

HIGHWAYS.

Pennsylvania.—An organization of the State Commission on Roads was effected at Harrisburg, Jan. 22, by the election of Senator A. D. HARLAN, of Chester, as President and CHARLES F. ETTLA, of Dauphin, as Secretary. Remarks were made by Governor BEAVER and nearly all the members of the Commission on the subject of roads. The subject was also discussed by Engineers ROBERTS and DEMPSTER, of Pittsburg.

New York.—The Board of Village Trustees of Mount Vernon has decided to send a petition to the Legislature for authority to bond the village in the sum of $100,000, to be raised in installments of $25,000 a year, the proceeds to be used in repairing the roads of the village.

Maryland.—A meeting of the taxpayers of the twelfth district of Baltimore Co. was held recently at Grange Hall, Patapsco Neck, to consider the improvement of roads. A permanent organization was formed, with A. J. ROGERS, Chairman and T. ALVAH MERRITT, Secretary. GEORGE R. WILLIS, T. B. TODD, JAMES M. GELLISPIE, A. MCCORMICK and JOHN H. SHERIDAN were appointed to serve for one year as an advisory board to the County Commissioners. They were instructed to recommend road supervisors, and thus do away with the petition system, by which, in the opinion of those at the meeting, many unfit persons were appointed.

Tennessee.—The Wartrace & Duck River Turnpike Co. will commence work at once. President, JOHN E. SHOFNER; Secretary, T. A. SHOFNER, of Wartrace, Tenn.

CONTRACTING.

Levees.—MR. WILLIAM STARLING, of Greenville, Miss., Chief Engineer of the State Board of Levee Commissioners, has recommended the construction of 10,000 cu. yds. of levee work.

Pier.—The following proposals have been received by the Dock Department, New York City: Fearon & Jenks, $4,722; J. D. Walsh, $4,739; J. W. Flaherty, $4,970; B. S. Cronin, $4,970; Fogg & Scribner, $5,550. The contract was awarded to Fearon & Jenks.

Scows.—The following proposals have been received by Major D. W. LOCKWOOD, U. S. Engineer Office, Cincinnati, O., for two dump scows, 45 ft. 5 ins. long and 17 ft. wide on deck; David K. Sprinkle, Cincinnati, O., $3,500; Madison Marine Ry. Co., Madison, Ind., $5,000.

Dredging.—The contract for dredging at Cleveland, O., has been awarded to John Stang, of Loraine, at 15 cts. per cu. yd.

Street Work.—*Brooklyn, N. Y.*—The following proposals have been received by JOHN P. ADAMS, Commissioner of City Works, for grading and cobblestone paving on Ralph St.: Dennis Norton, $5.25 per lin. ft.; Charles Hart, $4.36; Nolan & Kearns, $4.49; Thomas McDonald, $4.27; H. Bogert, $4.05; W. J. Hickey, $3.98; Henry Mogk, $3.78.

PROPOSALS OPEN.

Trenching.—Trenching, filling, and pipe-laying for 1,250 ft. of 8-in. sewer pipe. A. HINCHMAN, Mayor, Waco, Tex. Feb. 6.

Pipe.—About 10,000 ft. of 36-in. and 10,000 ft. of 16-in. cast-iron water pipe, with specials; also 3 to 12-in. pipe and castings. JOHN WHITELAW, Superintendent of Water-Works, Cleveland, O. Feb. 6.

Sewers, Pipe-Laying, etc.—Sewers, street improvement and laying water mains; furnishing brick, sand, sewer pipe, cement, manhole heads and covers. Improvements to old reservoir in Central Park (concrete, stone masonry, rock excavation, etc.) THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City. Feb. 6.

Scrapers.—For 100 to 150 road scrapers, No. 2, with steel runners. Wm. A. BRAMLETT, County Judge, Bonham, Tex. Feb. 9.

Filling.—Filling in 2 miles of the Pontchartrain trestle, by scrapers or barrows. Embankment 7 ft. high, 15 ft. wide on top, side slopes 1½ to 1. THE CHIEF ENGINEER, New Orleans & Northeastern R. R., 35 W. 4th St., Cincinnati, O. Feb. 10.

Electric Lighting.—Street lighting, 20 arc lights of 2,000 c. p., and 15 incandescent lights of 25 c. p. THE VILLAGE CLERK, Bath, Steuben County, New York. Feb. 10.

Sewers.—Furnishing materials and constructing 21 miles of pipe sewers, brick tunnel, outlet, manholes, etc. Pipe from 6 to 24 ins. diameter. FRANK W. KANE, City Engineer, Fort Worth, Tex. Feb. 10.

Pipe.—Furnishing 1,000 tons cast-iron water pipe. B. D. MCCONNELL, Superintendent of Water Works, Montreal, Canada. Feb. 18.

Brick.—Hard-burnt sewer brick; 500,000 beveled brick, 8 × 4 ins. and 3 × 2 ins.; 2,000,000 square brick, 8 × 4 and 2¼ ins. P. W. ST. GEORGE, City Surveyor, Montreal, Canada. Feb. 19.

Sewer.—Downing Ave. sewer. F. B. CROCKER, President Board of Public Works, Denver, Col. Feb. 19.

Masonry.—Stone and brick masonry of U. S. building at Port Townsend, Wash. J. H. WINDRIM, Supervising Architect, Treasury Department, Washington, D. C. Feb. 20.

Bridge.—Superstructure of Rich St. bridge over the Scioto River; two spans of 212.96 ft. and 256.41 ft.; 24 ft. roadway, two 6 ft. sidewalks; capacity, 100 lbs. per sq. ft. F. J. REINHARD, County Auditor, Columbus, O. Feb. 26.

Wells.—Drilling 5 wells. Price per foot. W. B. JONES, Clerk of Board of Water Works, Van Wert, O. Feb. 7.

MANUFACTURING AND TECHNICAL.

American Car & Equipment Co.—Mr. THOMAS B. INNESS has dissolved the firm of Thomas B. Inness & Co. for the purpose of connecting himself with the American Car & Equipment Co., 10 Wall street, New York.

Filters.—The National Water Purifying Co., New York, has orders for National filter plants for the Old Kentucky Woolen Mill Co., of Louisville, Ky.; THOMAS SEDDEN (of the Sloss Iron & Steel Works), Birmingham, Ala.; and the Water Works Commissioners, Bordentown, N. J.

Thos. Carling's Sons, of Allegheny, Pa., are adding to their facilities, owing to the large increase in their business. They are building shops, 250 by 120 ft., on River avenue, between the West Pennsylvania and the Pittsburgh & Western railways, which they will use for the manufacture of boilers, hoisting engines, contractors' machinery, ore pans and rolling mill machinery. They have recently placed on the market a hoisting engine with pumping attachment.

Stone Crushers.—The Porter Manufacturing Co., of Syracuse, N. Y., has orders for six of the Young & Brennan crushers.

The Addyston Pipe & Steel Co., of Cincinnati, O., has increased its capital stock from $1,200,00 to $1,500,000.

The Canadian Bridge & Iron Co. has been incorporated at Montreal. Capital stock, $75,000.

Spikes.—The Central Iron & Steel Co., of Brazil, Ind., has recently commenced the manufacture of railway spikes, and has erected a separate building for the purpose. It is fitted with a 10-in. train of rolls, one large gas heating furnace, and four Acheson patent spike machines, with a daily capacity of 300 kegs of 200 lbs. each.

Railway Shops.—It is stated that the contract for the Union Pacific shops at Denver, Col., has been awarded to Lantry Bros. & Co., for $500.000. This does not include the machinery. This firm is building the new roundhouse, which is to cost $100,000.

Journals.—The Car-Truck Supply Co. has been incorporated at Chicago by D. T. BUGLING, J. H. CAMPBELL and WM. TAYLOR, to manufacture the Hubbard self-oiling car-journal. Capital stock, $200,000.

Cement.—The Winfield Portland Cement Manufacturing & Mining Co., of Winfield, Kan., has been incorporated by ALONZO HOWLAND, J. D. PRICE, A. W SHAW, E. H. YOUNG and C. K. WILES. Capital stock, $150,000.

Stone Ballast.—The New York Central & Hudson River R. R. Co. will put up two large stone crushers for making ballast. One will be located near Montrose Station, and the other near Clinton Point, five or six miles south of Poughkeepsie.

The Midland Construction Co. has been incorporated at Chicago by G. W. NEEDHAM, W. L. Moss and E. L. WAUGH. Capital stock, $10,000.

Anti-Friction Bearings.—The Concord Horse R. R. Co., of Concord, N. H., which has voted to adopt electricity, has contracted with the Tripp Mfg. Co., of Boston, for the Tripp anti-friction journal bearings, which will be furnished with trucks complete. These bearings are said to be giving perfect success on various roads, and are rapidly coming into general use. The severe tests given these bearings has caused a considerable amount of discussion, and their durability is no longer experimental.

Metal Market Prices.—*Rails.*—New York: $35 to $36; old rails, $27 to $28 for iron, $22 for steel. Chicago: $38; old rails, $26.50 for iron and $20 to $21.75 for steel. Pittsburg: $35 to $36; old rails, $28.50 to $29 for iron, $24 to $24.50 for steel.

Track Material.—New York: steel angle bars, $2.15; spikes, $2.25. Pittsburg: splice bars, 2.10 to 2.20 cts.; spikes, $2.15 or $2.25, delivered at Chicago or St. Louis; track bolts, 3.10 cts. with square and 3.20 cts. with hexagon nuts. Chicago: splice bars, 2.25 cts. for steel and 1.90 to 2 cts. for iron; spikes, 2.25 to 2.30 cts.; track bolts, 2.80 to 2.85 cts. with square and 2.95 to 3 cts. with hexagon nuts.

Pipe.—Cast iron, about $27 to $30 per ton, according to competition and amount of order. Wrought iron: discounts as follows, 47½ per cent on black butt-welded, 40 on galvanized butt-welded, 60 on black lap-welded, 47½ on galvanized lap-welded. These discounts were changed at the manufacturers' meeting last week.

Lead.—New York, 3.80 to 3.85 cts.; Chicago, 3.65 cts.; St. Louis, 3.60 cts.

The Westinghouse Machine Co., of Pittsburg, Pa., states that seven of its "compound" engines are in use at one of the central stations of the Metropolitan Electric Light Co., London, England. Orders have been received for four more of these engines. An "automatic compound" engine has been ordered for Sweden, through the company's office at Copenhagen, Denmark. A 250 H. P. "compound" engine has been put in at the Baldwin Locomotive Works, Philadelphia, Pa., to replace a 200 H. P. "standard" engine. The change was made in about nine hours. The company states that improvements in printing work have been made by the use of small Westinghouse engines. A separate engine is attached to the jack shaft of each press. Thus each press is operated independent of any other press in the room, and of any other machinery, as for instance, that used in stereotyping. When it is desired that the press shall start on an edition, the engine is started; it starts slowly, thus starting the heavy web of paper revolving without shock and without tearing. The speed is increased as the work progresses, evenly and regularly, until a rate is reached in this way that is said to be impossible in any other.

Locomotives.—The Cooke Locomotive & Machine Co., of Paterson, N. J., are building 15 consolidation engines for the Union Pacific; cylinders, 22 × 28 ins.; boiler, 76 ins. diameter; weight, 153,000 lbs. These are said to be the largest and heaviest engines ever turned out at Paterson.

The Taunton Locomotive Mfg. Co., of Taunton, Mass., has finished four engines for the Baltimore & Ohio; cylinders, 18 × 24 ins.

The Rogers Locomotive Works, of Paterson, N. J., have orders for 10 consolidation and 10 switch engines for the Louisville & Nashville, and five freight engines for the Shenandoah Valley.

The Rhode Island Locomotive Works, of Providence, R. I., have built two Forney engines for a suburban road at Los Angeles, Cal.; also some engines for the Fort Scott & Gulf.

The Schenectady Locomotive Works, of Schenectady, N. Y., have delivered 15 heavy freight engines to the Illinois Central. Orders are on hand for 10 mogul engines for the New York Central; cylinders, 19 × 26 ins.

The Concord Ry. Co., of Concord, N. C., will purchase a dummy engine, with cylinders 12 × 18 ins.

Cars.—The South Baltimore Car Works, of Baltimore, Md., are building drop-bottom gondola cars for the West Virginia Central.

The Ensign Car Works, of Huntington, W. Va., are building 30 gondola and 100 coal cars for the Ohio & Big Sandy.

The Haskell & Barker Car Co., of Michigan City, Ind., is building 250 freight cars for the Cincinnati, Jackson & Mackinaw.

The Litchfield Car Works, of Litchfield, Ill., are building 200 refrigerator cars.

The Indianapolis Car Works, of Indianapolis, Ind., are building 900 cars for the Pittsburg & Western.

The Ohio Falls Car Co., of Jeffersonville, Ind., is building 20 passenger cars for the Georgia Central.

The New York, Pennsylvania & Ohio has ordered 500 freight cars; 500 more are to be purchased.

The Pennsylvania Co. has ordered 500 box cars from the Erie Car Works, Erie, Pa.; 500 from the South Chicago Car Works, and 200 from the Lafayette Car Works, of Lafayette, Ind.

The New York Central has added to its equipment 50 new passenger cars, equipped with the Pintsch system of gas lighting.

BRIDGES, TUNNELS, AND CANALS.

Bridges.—*Brockville, Ont.*—Application has been made to the Canadian Parliament for the authority to incorporate the Thousand Islands Bridge Co., to build a bridge across the St. Lawrence River near this place. R. C. CARTER, of Deseronto, Ont., is interested.

Grand Isle, Ont.—The following bids were received for the construction of the 200-ft. iron draw span at this place: Pittsburg Bridge Co., $5,125 and $5,509; Vermont Construction Co., $4,990; Berlin Bridge Co., $5,300; King Bridge Co., $5,138; Variety Iron Works, $5,200; Phœnix Bridge Co., $7,850 Groton Bridge Co., $5,180. The contract was awarded to the Vermont Construction Co., of St. Albans, Vt.

Warren, R. I.—Bids were received as follows on the 136-ft. wrought iron draw span at this place: Berlin Bridge Co., $6,950; Dean & Westbrook, $10,225 and $7,550; Pittsburg Bridge Co., $6,700; Pennsylvania Bridge Co., $7,450;

Wrought Iron Bridge Co., $7,950; Smith Bridge Co., $9,650 and $7,850; New Jersey Standard Iron Co., $6,721; Boston Bridge Co., both structure and superstructure, $22,408. Lowest bid on masonry alone, J. L. Lack, $14,500.

Buffalo, N. Y.—The City Engineer has received the following bids for constructing a stone-arch bridge over Cornelius Creek, on Tonawanda St.: Franklin & Olsen, $2,390; W. A. Green, $2,893; Peter G. Straub, $3,135; G. Olsen, $3,249; W. F. Kinch, $3,250; George Martin, $3,450; D. W. McConnell, $3,495; A. Krouse, $3,590; Philip Marburg, $3,714; John Mumm, $3,800; W. G. Smith, $4,849.

Buffalo, N. Y.—It is announced the Union Bridge Co., having works at Buffalo, N. Y., and at Athens, Pa., will abandon the works at Athens and concentrate the entire plant at Buffalo. The reason given for the removal that better traffic facilities can be had at Buffalo.

New York, N. Y.—The Board of Street Openings has granted permission to the Pennsylvania R.R. Co. and the Central R.R. Co. of New Jersey for the erection of two bridges over West St., at Cortlandt St. and at Rector St. Work will begin upon both structures at an early date.

New York, N. Y.—A bill has been introduced into Congress authorizing the North River Bridge Co. to construct a bridge over the North River between New York and Jersey City.

New York, N. Y.—At a meeting of the Board of Estimate recently held, Corporation Counsel CLARK was authorized to take the necessary steps for condemning the land required for the proposed viaduct from St. Nicholas Place to McComb's Dam Bridge. At the next meeting Commissioner Gilroy will present his report, giving the approximate cost of the structure, including real estate. The commissioner believes that the cost will fall below $510,000. State Engineer BOGART also asked for $450,000 for securing needed approaches to the new Washington Bridge. No action was taken.

Syracuse, N. Y.—At a meeting of the City Council it was voted to enter into contract for the bridge over the tracks of the Delaware, Lackawanna & Western Railroad. The bridge will cost about $50,000.

Troy, N. Y.—The contract for a trestle for the Troy Steel and Iron Co., on Breaker Island, has been awarded to Emmett Flagler, for $15,000. It will be about 1,300 ft. long.

Philadelphia, Pa.—A bill has been introduced into Congress for a suspension bridge over the Delaware River at this place. It will cost about $4,000,000. Further notice will be found in our "Engineering News" columns.

Pittsburg, Pa.—It is announced that the proposed bridge across the Allegheny River, from the foot of Arch street, Allegheny, to the foot of Fifth street, Pittsburg, will be built. The name of the company is the Fifth Street Bridge & Viaduct Co., Jos R. SCOTT, President; J. W. GROVE, Secretary. The structure will cost about $500,000.

Cincinnati, O.—At a citizens' meeting recently held it was resolved to petition the State Legislature for authority to construct the proposed Eighth street viaduct. The structure will cost about $250,000.

Columbus, O.—FRANK J. REINHARD, County Auditor Columbus, O., will receive proposals up to Feb. 26, 1890, for the superstructure of the Rich Street bridge over the Scioto River; two spans 212 ft. and 256 ft. respectively, 24 ft. roadway; two 6-ft. sidewalks; capacity, 100 lbs. per sq. ft.

Charleston, W. Va.—A charter has been granted to the Charleston & South Side Bridge Co., empowering it to build a bridge over the Kanawha River at this place. The incorporators of the company are: B. L. WOOD, Jr., President, and W. P. WOOD, both of Pittsburg, Pa.; R. S. CARR, S. M. SNYDER and W. H. DAWNE, of Charleston, W. Va. The engineer of the company is S. C. WEISKOPF, Room 314, Penn Building, Pittsburg, Pa., to whom all communications pertaining to the engineering matters should be addressed.

Florence, Ala.—J. J. MITCHELL, Judge of Probate, Florence, Ala., will receive bids for the construction of a bridge across Cypress Creek, near this place. The bridge will be 180 ft. long, with a 16 ft. roadway.

Louisville, Ky.—City Engineer SCOWDEN has prepared plans for an elevated roadway and bridge from Campbell St. to Burret Ave., over the tracks of the Louisville & Nashville R. R. The total length will be about 1,000 ft.

La Crosse, Wis.—The contract for building the drawbridge across the Mississippi River at this place has been awarded to Clinton Bridge Co. for $80,000.

Manitoba.—Bids are asked for the construction of a pile bridge across Elm River. Address PETER KIRTON, Readburn, Mass.

Minneapolis, Minn.—The contract for the pile bridge over Keegan's Lake has been awarded to E. T. COMSTOCK & Co. at $1,770 for the lumber, and 16¼ cts. per lin. ft. for the piling.

Sauk Center, Minn.—City Clerk A. H. PETTIT will receive proposals up to Feb. 10 for the construction of two iron bridges. One at Sauk Center, 165 ft. span, 18 ft. roadway, and two 5 ft. sidewalks. The other at New Munich, 140 ft. span, 16 ft. roadway. Both bridges to be on iron cylinder piers. Bids can be made for both bridges, or each separately.

Indian Territory.—A bill has been introduced into Congress providing for the construction of a bridge across the Arkansas River, to be constructed and used by the Kansas & Arkansas Valley R.R. Co.

Cummins, Ark.—Plans have been completed for the proposed bridge across the Arkansas River at this place. It is to be 1,200 ft. long, with 5 spans, and a draw span of 300 ft.

Brazos Terminal Ry. Co.—The Secretary of War has approved the plans for the bridge across the Brazos River, Texas, to be built by this company.

Comanche, Tex.—Bids will be received for the construction of six bridges. Address CHAS. E. WILLIAMSON, County Judge.

Colorado.—State Engineer MAXWELL has awarded the contract for the bridge across the Grand River, noticed in our issue of Jan. 18, to the Missouri Valley Bridge Co. for $5,190. The bridge will consist of two spans of 100 ft. each.

Proposed.—Bridges are proposed at the following places: Walden, N. Y.; Dresden, O.; Shepherdsville, W. Va.; Machen, Ga.; Red Wing, Minn, and O'Neill, Neb.

ELECTRICAL.

Electric Light.—*Biddeford, Me.*—The city has renewed its contract with the Biddeford & Saco Light & Power Co. for 45 lights at $100 each per annum. The contract is for 20 years.

Woodsville, N. H.—The Woodsville Aqueduct Co. has appointed E. B. MANN, D. L. HAWKINS and C. ABBOTT a committee to negotiate for putting in an electric light plant.

Canton, Mass.—The Blue Hill Electric Light Co. will be granted a franchise as soon as its capital stock of $20,000 is paid up. THOMAS BLANCHARD, of Stoughton, is President.

Rockville, Conn.—The council will probably contract for the 74 lights at $75 each per annum.

Oswego, N. Y.—The Oswego Electric Light Co. will put in a plant with a capacity of 200 arc and 2,700 incandescent lights.

Sandy Hill, N. Y.—The Sandy Hill Electric Light and Power Co. has been incorporated by M. C. ALLEN, J. E. HOWLAND and J. J. CUNNINGHAM. Capital stock, $15,000.

East Orange, N. J.—The Orange Electric Lighting Co. has been incorporated. The Edison incandescent system will be used for street and domestic purposes. The wires will be laid underground. Mr. J. C. BAYLES is President.

Meadville, Pa.—The People's Incandescent Light Co. has been organized by F. R. SHYROCK, J. S. LINDEMAN and C. E. RICHMOND. Capital stock, $25,000.

Grafton, W. Va.—A contract for electric lighting has been awarded to A. R. CAMPBELL.

New Cumberland, W. Va.—The New Cumberland Light, Heat & Power Co. will put in an arc and an incandescent plant.

Mt. Sterling, Ky.—The city has awarded the contract for an electric light plant to the Thomson-Houston Co., of Boston.

Winston, N. C.—The Winston Electric Light Co. has sold out to the Sprague Electric Co. of New York.

Magnolia, Miss.—It is proposed to put in a plant to supply Magnolia, Summit, and McComb City.

Nashville, Ill.—A local company with $10,000 capital has been organized to put in an electric light plant. G. W. ATTERBURY, of Litchfield, is working in the interests of the Thomson-Houston Co.

Chicago, Ill.—The Fidelity Electric Light Co. has been incorporated by A. W. BULKLEY, E. E. GRAY and A. N. EASTMAN. The capital stock, $15,000. The Cross Primary Battery Electric Light & Mfg Co. has been incorporated by E. D. CROSS, W. V. GRIFFIS and F. C. RUTAN. Capital stock, $1,000,000.

Elgin, Ill.—The Elgin Electro-Hydraulic Co. has been incorporated to furnish light and power. Capitals $250,000.

Austin, Tex.—It is proposed to utilize the water power to operate an electric light plant.

Cuero, Tex.—An electric light plant is to be put in as soon as the water-works are completed.

The Thomson-Houston Electric Co. reports sales as follows: arc apparatus to central stations, 23 towns, with an aggregate of 1,400 lights; incandescent apparatus to central stations, 30 towns, with an aggregate of 22,350 lights; arc and incandescent apparatus for isolated plants, 4 arc plants, with an aggregate of 98 lights; 10 incandescent plants, with an aggregate of 1,900 lights.

SEWERAGE AND MUNICIPAL.

Street Work.—*Ashland, Ky.*—It is proposed to issue bonds for $15,000 for street paving.

Pittsburg, Pa.—The Board of Public Works has passed several ordinances for street paving, and considerable work will be done this summer.

Savannah, Ga.—Proposals will soon be advertised for asphalt paving. For particulars address W. J. WISE, City Engineer.

Alpena, Mich.—The contracts for 26,812 sq. yds. of cedar block paving have been let to J. A. WIDNER and T. S. DEWEY at 63 cts. per sq. yd.

Leavenworth, Kan.—The city engineer has prepared estimates for macadam or Telford pavement on Metropolitan Ave.

Sewerage.—*Revere, Mass.*—It has been decided to petition the Legislature for power to put in sewers. The matter has been investigated by Engineers T. L. FULLER, of Boston, and W. E. MCCLINTOCK, of Chelsea.

Nantasket, Mass.—A meeting will be held March 3 to consider the question of issuing bonds for sewerage purposes.

Mount Vernon, N. Y.—The trustees have asked for an issue of $50,000 in bonds for sewers.

Flatbush, N. Y.—Six bids have been received for the surface water sewer on Flatbush Ave. The estimate of the engineer, Mr. GARRETT BERGEN, was $105,000.

Jamestown, N. Y.—The sewer question is being agitated, and an engineer is to be appointed to investigate the subject.

Kearny, N. J.—Mr. YOUNG, the surveyor, has been directed to prepare plans for the Woodland Ave. sewer. His estimate for the Kearny Ave. sewer is $25,000.

East Orange, N. J.—The Township Committee will issue $15,000 sewer loan bonds at 4 per cent., and $50,000 or $57,000 street improvement bonds at 6 per cent.

Portsmouth, Va.—The Portsmouth Sewerage Co. has been incorporated by HENRY KERN, ADOLPH BRANDT and M. D. EASTWOOD.

Vicksburg, Miss.—It is proposed to issue bonds for $100,000 for establishing a sewer system.

Ogden, Utah.—An ordinance has been passed authorizing the issue of $50,000 in bonds for a sewer system.

Walla Walla, Wash.—It is proposed to put in a system of sewers at a cost of about $200,000.

Oakland, Cal.—A company represented by GREY OLIVER, of Porterville, Cal., has made a proposition to do the entire work (estimated by Mr. HERING to cost $379,466, plus $30,000 for a pumping plant), for $385,000, or would make a bid on all the pipe needed.

West Toronto Junction, Ont.—It is proposed to engage engineers to report upon a system of sewerage suitable for a population of 50,000.

WATER-WORKS.

NEW ENGLAND.

Burlington, Vt.—In the annual report of the Water Commissioners it is recommended that the old reservoir be cleaned and repaired and be used for additional fire protection. Various sources for a new supply have been investigated, and steps will probably be taken during the coming season to carry out the projected plans.

Lowell, Mass.—A joint order has been adopted authorizing the Mayor, City Treasurer and City Solicitor to appear before the Legislature and ask permission to make a loan not exceeding $1,000,000 for the purpose of refunding the water loan, a large portion of which falls due this year.

Leicester, Mass.—We have received the following information:

Contracts have been made for laying about 4,000 ft. of pipe, only. Water will be conveyed from springs by gravity to a tank, 30 ft. in diameter by 55 ft. high. The commissioners are: H. O. SMITH, W. L. WHITTEMORE and H. L. WATSON. The estimated cost of the completed works is $40,000 to $50,000, procured by bonds.

Uxbridge, Mass.—The town has recently voted to take by purchase the franchise and property of the Uxbridge Water Co., and a committee has been appointed with instructions to confer with the company, and agree, if possible, on the sum which the town shall pay for its franchise and plant, and report the amount necessary to complete the purchase, and a plan for raising the same by bonds, notes or otherwise. The report will be submitted on March 3.

Malden, Mass.—At a recent meeting of the Common Council $4,627.84 was ordered transferred from the appropriation for water supply to the appropriation for water construction.

MIDDLE.

Camden, N. J.—At a recent meeting of the Water Committee, a proposition was received from the Real Estate & Investment Co., offering $600,000 cash for the existing plant, and guaranteeing a purer supply of water from sheds, 11 miles distant.

Du Bois, Pa.—A satisfactory test of the new works was made on Jan. 15. The supply is pumped from springs, 7¼ miles distant, to a reservoir. The works were constructed by the Michigan Pipe Co., of Bay City, Mich.

Cumberland, Md.—The water supply is reported to be polluted and unfit for use. As a remedy, it is proposed to extend the supply pipe further into the river.

Belair, Md.—At a recent public meeting a unanimous vote was taken in favor of contracting with a stock company, to be organized, bonds being guaranteed by them to the extent of $30,000, to build and control the works, the town to pay $800 the first year, $700 the second year and $600 per year for 18 years thereafter. Surveys and estimates have been made by ARTHUR R. T. LACKEY for complete works. The proposed sources of supply are

Winter's run, 2 miles south of the town, or Bynum's run, 1¼ miles north. Both of the streams named are considerably below the level of the town, and the water will have to be forced by a water-wheel into a stand-pipe. The estimated cost of the works is $33,000 to $36,000.

Yonkers, N. Y.—The Common Council has authorized the issue of $25,000 of bonds to extend the water service to Nodine Hill.

Newark, N. J.—Engineer JACOBSON is preparing plans for a new storage reservoir to have a capacity of about 1,500,000 galls. It will be located within the city limits. Estimated cost, $300,000. Authority from the Legislature will be necessary.

Hamburg, Pa.—Engineer M. M. DREIBELLIS sends us the following:

The Windsor Water Co. has awarded the contract for constructing works to Howard E. Ahrens, of Reading, Pa. Pipelaying was comenced in December, 1889. Water will be conveyed by gravity from Mill Creek to a reservoir. President, P. D. WARNER, of Reading; Treasurer, R. B. KINSEY.

Elkton, Md.—A committee has been appointed by the citizens to draft an amendment to the town charter, to be presented to the Legislature, permitting the erection of water works.

SOUTHERN.

Hickory, N. C.—J. H. HALL, Mayor, informs us that nothing definite has been done.

Brunswick, Ga.—The South Brunswick Telegraph, Telephone, Electric Light & Water Co. has been incorporated.

Weston, W. Va.—W. J. KITSON has been engaged to prepare plans and specifications for a system of works for the Weston Electric Light, Power & Water Co.

Talladega, Ala.—It is probable that a considerable amount of extensions and improvements will be made during this season.

NORTH CENTRAL.

Coshocton, O.—A bill has passed the Legislature authorizing the town to borrow money and construct works.

Lebanon, O.—M. E. GUSTIN, City Clerk, has sent us the following:

The bid of Snyder & Williams, of Dayton, O., has been accepted, but no binding contract will be mad until a citizens' vote is taken in April. The estimated cost is $45,000. Water will be pumped from driven wells to a stand-pipe. Hydrants will be used. Population, 4,000.

Marietta, O.—The new works will be completed about July 1.

Toronto, O—The following bids have been received by O. Y. Crawford, Secretary:

C. H. Connell, Youngstown, O., reservoir, $12,140.60; pump well, $2,440.

Distribution pipes, Geo. Hibbard, specials, $44.25; 4 in. $20.20; 6-in., $29 25; 8-in., $29.25; 10-in., $29.25; 12-in., $29.25; force mains, 8-in., $29.25; 10-in., $29.25.

R. D. Wood & Co., Philadelphia, Pa., $60: $29.25; $29; $29; $28.70; $28.70; $28.70; $28.70.

National Pipe Works, $50; $29.40; $29; $29; $28.70; $28.70; $28.70; $29.40.

Lake Shore Foundry, Cleveland, O., $50; $29.40; $29; $29; $28.70; $29; $28.70; $28.70; no bid; $29.40.

Dennis Long & Co, St. Louis, Mo., $62.50; $31.25; $29; $29; $28.70; $28.70: no bid; $33.25.

Strickler Iron Co., $64; $34.50; $30.25; $29; $28.70; $28.78; no bid; $33.50.

Addyston Pipe & Steel Co., $49.90; $27.97; $33.50; $29; $28.80; $28.70; $27.97.

Influent pipe, Geo Hibbard, 16-in. and 20-in., $29.25.

Lake Shore Foundry, $29 40.

National Pipe Works, $28 30.

Dennis Long & Co, $30.25.

Sickles Pipe Works, $33.50.

Addyston Pipe & Steel Co., $27.97.

Valves and hydrants, Bourbon Brass & Copper Co., 45 fire hydrants, $1,462; Rensselaer Mfg. Co., valves, $629.50; C H. Cornell, hydrants, $60 50.

Pumping machinery, Gordon Steam Pump Co., $20.475.

Pipe laying, Rockford Construction Co., 16 cts. to 29 cts. per ft.

Cleveland, O.—The trustees of water-works will receive sealed proposals until Feb. 6 for furnishing and delivering, as required, 10,000 ft. of 36-in., 10,000 ft. of 16-in. cast-iron water pipe, with special castings; also for such cast-iron water pipe, from 3 in. to 12 in. in diameter, with the necessary special castings, as may be required during the year 1890. Bidders to use the printed forms furnished by the Board. All others will be considered informal. The trustees are: GEO. S. PAINE, E. J. BLANDIN and C. H. PRITCHARD. Superintendent and Engineer, JOHN WHITELAW.

Huntington, Ind.—We have received the following information from Jos. M. BLACK, City Clerk:

Proposals will be received until Feb. 10. The following supplies will be needed: 16 3-5th miles of 6 to 16 in. pipe; 150 hydrants; stand-pipe, 25 ft. in diameter by 150 ft. high; valves (sizes and number not named); two pumps, each having a capacity of 1,500,000 galls. per 24 hours. JACOB SPEAKER is Chairman of the Water Works Committee. The works will be constructed by a company, the city paying an annual rental. The estimated cost is $125,000 to $150,000. Population, about 10,000.

Van Wert, O.—Bids will be received until Feb. 7, for sinking five wells in accordance with plans and specifications on file with W. B. JONES, Clerk of the Board of Water Works. Proposals for $5,000 of 4½ per cent. bonds will be received until Feb. 25 by HENRY ROBINSON, Village Clerk.

Vincennes, Ind.—A. W. MACCALLUM, of Camden, N. J., informs us, that the notice in our issue of Jan. 25 stating that those works had been rendered useless by recent floods, probably refers to the Washington, Ind., works. He states: "The storms damaged four suction pipe a trifle, but the pumps have been running every day since the works began operation."

NORTHWESTERN.

Hull, Ia.—A small system of works will probably be constructed. Estimated cost, $3,000 to $6,000. The contract for sinking an artesian well, from which the supply will be taken, has been let. ROBERT PATTERSON, Mayor.

Missouri Valley, Ia.—The new works have been satisfactorily tested. They were constructed by the Fremont Foundry & Machine Co. Engineer, J. S. WATTLES. Superintendent of Construction, C. H. GODFREY.

Omaha, Neb.—C. H. Venner & Co. of New York City, are now offering $1,000,000 of 6 per cent. bonds for sale. They are issued by the American Water-Works Co. WILLIAM A. UNDERWOOD, President.

Denver, Col.—The Citizens' Water Co. has awarded a contract for 6,000 tons of cast-iron pipe to the Shickle, Harrison & Howard Iron Co., of St. Louis, Mo. The pipe is to be delivered by June 1, 1890. The size of the pipe varies from 30 in. down. The company now has the drawings of the entire work to be done, including the reservoirs, and the piping from it, to and through the city, on file. The company has made a contract with South Denver whereby control of the existing plant is secured, and within 60 days pipe will be laid through that portion of the city lying between Cherry Creek and the south boundary of the city. Water will then be furnished from the South Denver system until the new supply is obtained.——It is now reported that the Denver Water Co. has awarded a contract to the American Water Works Co., of Omaha, Neb., for $2,000,000 worth of improvements to their system. The contract was let on Jan. 2, and on the same day the contractors ordered 15,000 tons of cast-iron pipe to complete the system. In addition to this, the wooden pipe now used will be replaced by cast iron pipe of the same sizes. Water for the reconstructed works will be furnished by gravity. Two 6,000,000 gal. Gaskill pumps will be used temporarily to aid the water supply during the coming year in order to meet the demands.

The proposed plan for piping the city comprises three complete circuits of 18 and 24 in. pipes, one inside the other, with all the cross streets laid with 14, 16 and 18 in. pipes, connecting the three circuits with each other. North Denver is now supplied by one 10 in. pipe on Fifteenth street, and preparations are being made to construct 16 in. pipe lines on Seventh, Nineteenth and Twenty-seventh streets, which will connect with each other on the other side of the river, making a complete circuit.

The engineering work will be under the supervision of Captain EDWARD RUGER.

SOUTHWESTERN.

St. Joseph, Mo.—Bonds for $300,000, bearing 6 per cent. interest, are being offered for sale by Hill, Payson & Co., of Portland, Me.

Little Rock, Ark.—Hill, Payson & Co., of Portland, Me., have $160,000 of 6 per cent. bonds, issued by the Arkansas Water Co., for sale.

Cisco, Tex.—J. H. BEAL informs us that he willbuild a system of works as a private enterprise. Estimated cost, $40,000. Water will be pumped to a stand-pipe. Work will be commenced about March 1, and be completed by Sept. 1.

Cleburne, Tex.—The City Council has accepted the proposition of S. E. Moss to furnish the city with a supply of water sufficient for 20,000 inhabitants, within one year after signing contract. When completed, the city is to deliver the existing works to Mr. Moss.

El Paso, Tex.—The City Council has declared the charter of the water company forfeited, and will resubmit the question of issuing $75,000 of bonds, for establishing its own works, to its citizens on Feb, 21.

Rockdale, Tex.—The following information has been received from SOLON JOYNES:

The people are agitating the question of fire protection and water supply, and the city offers to patronize a system to the amount of $1,000 per annum. "There is an opening here for water-works builders." The proposed source of supply is wells, or Good River, 4 miles distant. Population, 2,000.

Maxwell, N. M.—(P. O. at Springer.) A reservoir to have a capacity of 10,000,000 galls. is being constructed. It will give a pressure of nearly 100 ft. in the town. The water to be used for town purposes will pass through large filters.

PACIFIC.

Seattle, Wash.—Plans for the contemplated improvements will soon be completed. Bids for part of the work will soon be wanted.

Tacoma, Wash.—A contract has been closed with the John Barrett Co., of Portland, by the Fairhaven Water & Power Co., for putting in complete works for public and private use and fire protection. The system includes the laying of about 7 miles of pipe. Water will be taken from Lake Padden, 3 miles distant, and of sufficient elevation to furnish ample pressure for any purpose. There will be 3 miles of 12-in. mains.

Port Townsend, Wash.—Preliminary surveys have been completed. Several reservoirs have been constructed.

Albina, Ore.—A new company, the Albina Light & Water Co., has been formed with a capital stock of $50,000. H. C. CAMPBELL is at the head of the new company. The plant of the Albina Co. has been purchased for $20,000; also a lot 75 × 100 ft., on which a new pumping station will be erected. Two steam pumps, with a daily capacity of 15,000,000 galls., will be purchased. A battery of 3 boilers with 300 H. P. will be used for the various engines.

Joseph, Ore.—A small system of works has been constructed.

Oakland, Cal.—The Contra Costa Water Co. states that it is its intention to enlarge and extend its present system of aeration and filtration, and to proceed with the construction of a large aerating and distributing reservoir at or near East Oakland.

Fort Bragg, Cal.—The Fort Bragg Water Co. has been organized to supply the city with water. Capital stock, $200,000.

Provo City, Utah.—Engineers Sturgas & Bryant, of Salt Lake City, have been engaged to design a system of works.

Salt Lake City, Utah.—In the report of the Commissioners appointed in April to investigate the question of securing an ample water supply, the following recommendations are made:

We desire to impress the fact that a daily supply of 8,000,000 galls. can be secured in the vicinity of Liberty Park, by sinking about 24 wells; 12 to 115 ft level, and 12 to 260 ft. level. The cost will be about $4.50 per foot, or a total of $20,250.

From the wells sunk in Utah Valley 5,000,000 galls. is being obtained daily, and it is recommended that additional wells be sunk, and the water conveyed to the canal through Jordan River. A masonry conduit, about 28 miles long, will probably be built within two years to replace the Salt Lake City canal. F. HEWSON SMITH is Chairman.

CANADA.

Wolfville, N. S.—Works are being constructed. Address DE WOLF BARSS, Secretary.

Montreal, P. Q.—Sealed tenders will be received until Feb. 18 for furnishing 1,000 tons of cast-iron water pipe, to be delivered in quantities and at dates stated in specifications. Address B. D. MCCONNELL, Superintendent.

Beauharnais, P. Q.—Works costing $20,000 are to be established. R. WILSON SMITH has charge of the matter. Engineer J. EMILE VANIER has charge of the building of the works. Water will be pumped from the St. Lawrence River.

Lucknow, Ont.—The new works have been satisfactorily tested. The contractors were MCQUILLAN & Co.

ARTESIAN WELLS.

Beeville, Tex.—A well will probably be sunk. Address the Town Clerk.

Iroquois, Dak.—A contract has been let for putting down a well. Work will soon be commenced.

Savannah, Ga.—The water committee has been authorized by the City Council to purchase equipments for sinking 6 wells to a depth of 1,000 ft.

Dallas, Tex.—Propositions for boring for artesian water will be received by Mayor COMER.

Kimball, Ia.—The well has reached a depth of 1,000 ft.

IRRIGATION.

Turlock, Cal.—The Board of Directors of the Turlock Irrigation District have rejected all bids for the first 4 miles of ditch, except those of R. W. Gorrill and Hamilton W. Gray, which were taken under consideration until Jan. 20.

Denver, Col.—The Powell Park Ditch Co. has filed a certificate recently with the Secretary of State, increasing its capital stock to $12,500. An ordinance has been introduced into the Common Council providing for the construction of a pipe line for conducting water for irrigating purposes from the Rocky Mountains to the city limits. The estimated cost is $6,500,000. WOLFE LONDONER is Mayor.

Cheyenne, Wyo.—The Burlington & Missouri R. R. Co. is negotiating for the purchase of 40,000 acres of land near Saratoga, Wyo. The company intend to construct a canal from the North Platte River to cover this tract and furnish water to settlers on government land. The details of the plan will be in charge of Coe & Coster, of Omaha, Neb.

Denver, Col.—The Colorado Land & Water Co., which is to construct a system of irrigating canals, consisting of about 225 miles, and 15 large storage reservoirs of sufficient capacity to irrigate about 500,000 acres of Government and State lands, lying on both sides of the Arkansas River in the Counties of Pueblo, Ottero and Kiowa, in Colorado, have placed a contract with W. C. Bradbury & Co., railway contractors, of Denver, for their construction. The supply will be taken from the Arkansas River. About 1,500 teams, and 3,000 men will commence work at once on the first 100 miles of the main canal.